Bell Telephone

Electrical Communications in World-wide Warfare:
On the Ground • In the Air • At Sea

Operator Toll Dialing—A New Long Distance Method
JAMES J. PILLIOD AND HAROLD L. RYAN

The West Coast in the War • GEORGE H. JESS

Bell Telephone Magazine

Summer 1945

EDITORS' NOTE: Two of the three articles listed below deal with communications at war. As these pages go to press, there are indications that the surrender of Japan is imminent, and therefore this issue may be distributed in a world at peace. If that should happily be so, the articles will perhaps have no less interest as a record of some of the ways in which communications have contributed to the victory.

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A Medium of Suggestion & a Record of Progress

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Electrical Communications in World-wide Warfare

Major General Harry C. Ingles

I. *On the Ground*

By Major General Harry C. Ingles

CHIEF SIGNAL OFFICER, UNITED STATES ARMY

ALL AMERICANS are overjoyed at the glorious victories won in Europe by the forces of the United Nations. Hundreds of officers participated in planning the crucial battles of the final campaign against Germany. These battles were led by thousands and fought by millions, but they were directed by one man—the Supreme Commander—who dealt with the destinies of nations and the lives of countless human beings.

Vital to victory was the prompt and certain transmittal of battle orders from the highest echelon down through the chain of command to corps, to divisions, and thence to smaller units, and the immediate translation of those orders into coördinated action.

The instrument by which coördination was achieved is military communication. It is the responsibility of the Signal Corps to supply the Army with a system of communications which radiates from the War Department in Washington to every spot where American troops are in action. It is a system which shapes the pattern of our armies' movement and striking power, serves every commander and every soldier, and holds them together in united action.

In fashioning this vast network and in manning and producing its equipment, the Signal Corps has had the unstinted support of the entire electronics industry and the commercial communications companies. These organizations have placed the war needs of the Nation above all other considerations. Their response to all military demands has been prompt and patriotic. By their unselfish public service they have earned the lasting gratitude of the country.

It is my confident conviction that this splendid coöperation will continue not only until Japan has been defeated but far into the coming years of peace.

The Main Channels of Military Communication

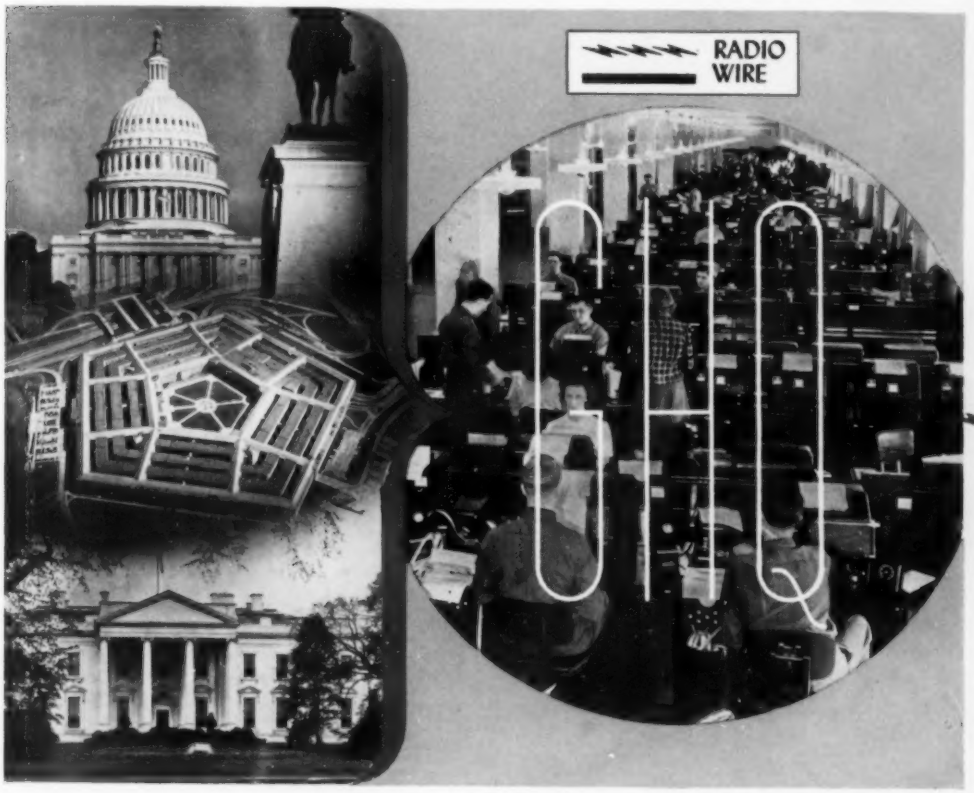
OUT OF this nation's prosecution of global war has come in a few swift years a military communications system unparalleled in history. On every continent and across every ocean it carries messages at incredible speed and in incalculable number.

Many men are needed to install and maintain and operate this globe-encircling system. There are more men in the Army Signal Corps today than in the entire U. S. Army of six years ago, and the communications specialists in other branches add many thousands more to the total.

The Signal Corps catalog of equipment lists more than 100,000 separate items, of which about 1,000 are of major importance. The quantities in which they are made and used are best expressed not in numbers but in thousands of tons.

This communications system exists for but one purpose: to unify into a single organism the staffs at Washington and in the theaters of operation, armies, corps, divisions, regiments, battalions, companies, platoons, patrols—integrating them with one another and with the grand plan of global strategy.

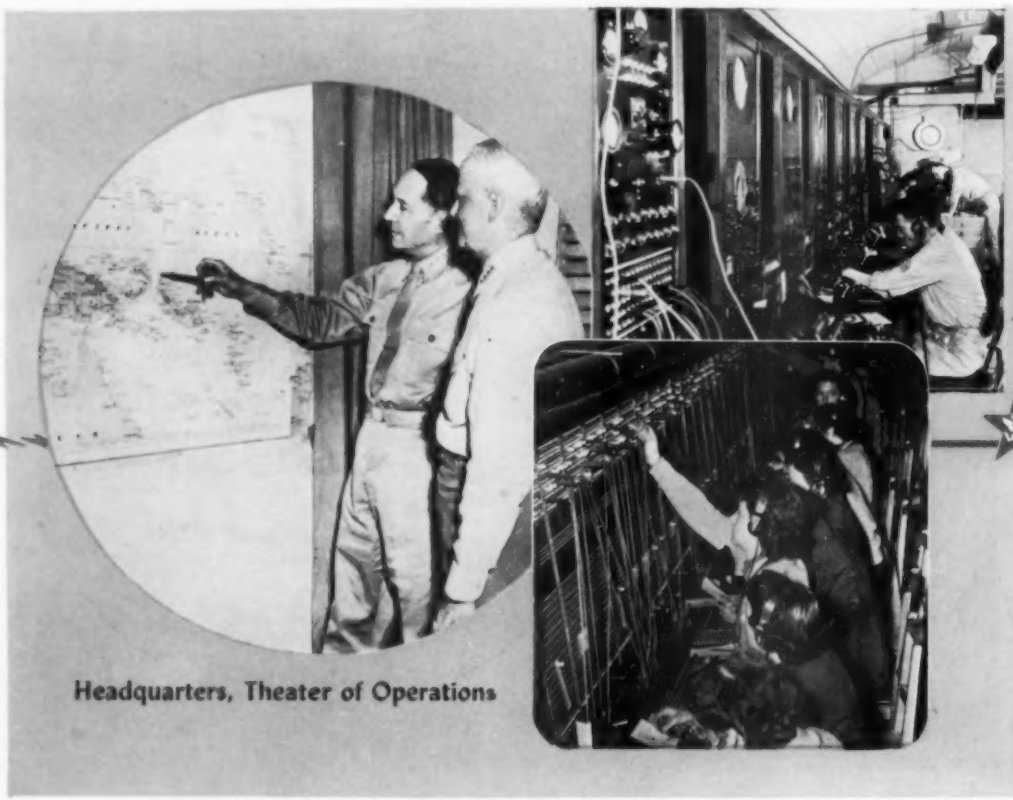
The system's vastness and complexity are beyond description. But it is possible—by over-simplifying, by narrowing down, by eliminating the intricate secondary and lateral lines interconnecting all branches and



services—to represent graphically the main channels of military communication. On the lower halves of these dozen pages are shown an "ideal" arrangement of wire and radio circuits, typical to greater or less degree of any theater in which American troops are engaged, over which messages may pass "from Pentagon to foxhole."

SOLDIERS and civilian personnel operate these teletypewriters at an overseas headquarters

The photographs on the upper halves of these 12 pages illustrate the military importance of electrical communications of many kinds and in many fields of combat

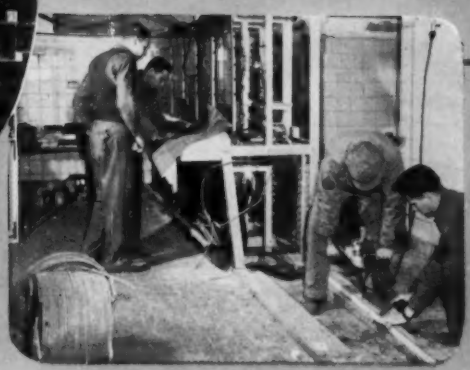


Headquarters, Theater of Operations

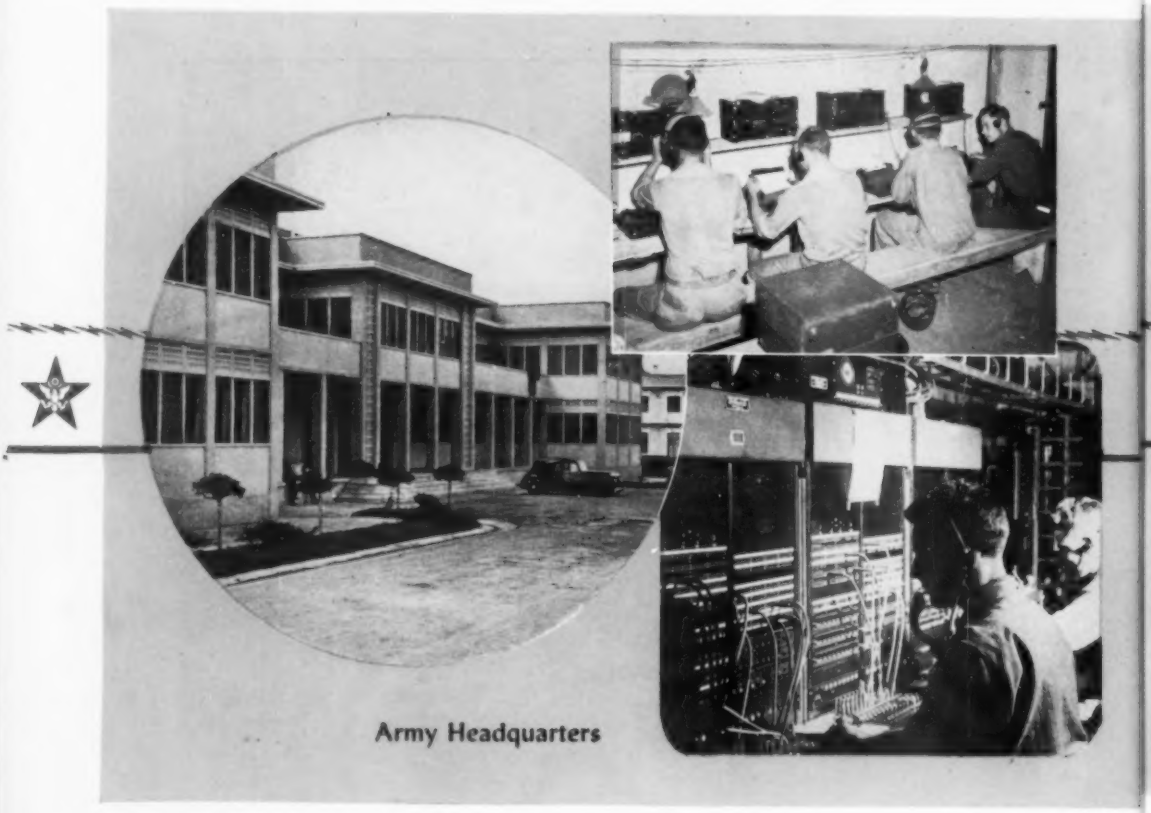
A TELEPHONE POLE left standing near Manila by the Japs comes down to repair a bridge which they demolished

BATTLE-TORN Manila's communications are revived as U. S. Signal Corps troops restore telephone cable

Army Group Headquarters

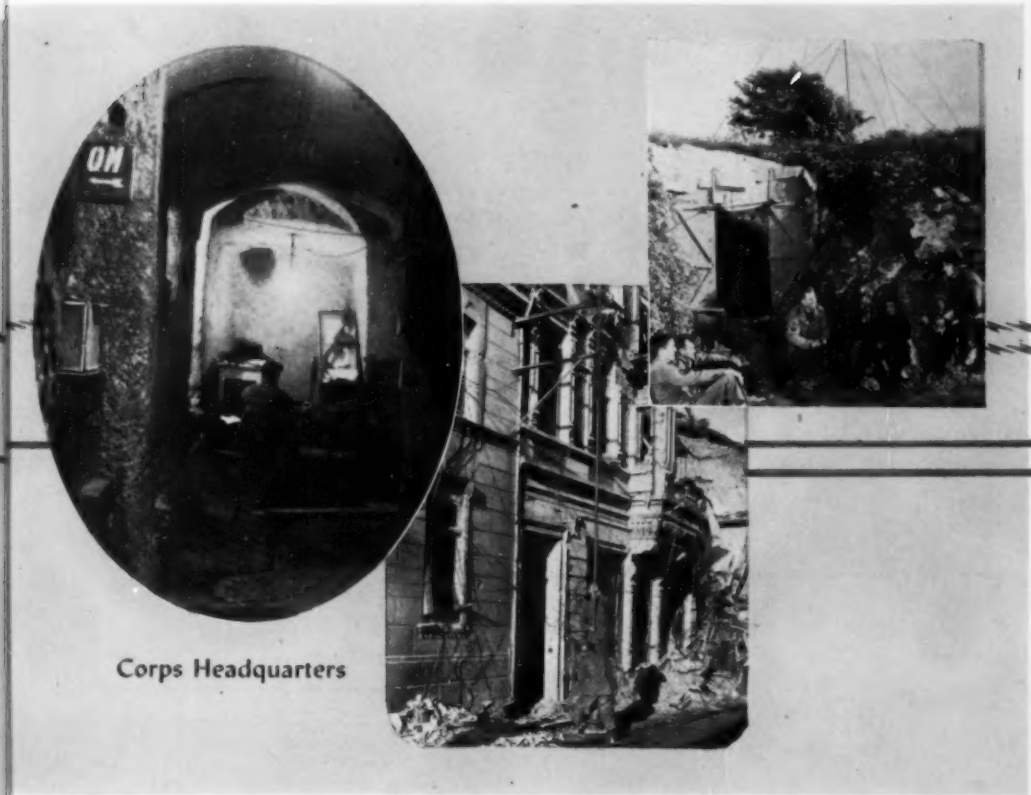


TELEPHONE WIRE must penetrate dense tropic jungles, as here on Bougainville, where trees serve the moment's need as telephone poles



Army Headquarters

IN THE China-Burma-India theater, an American officer and Chinese troops observe the effect of artillery fire against the Japanese



Corps Headquarters

THIS forward command post overlooks Lemon Valley on Leyte Island in the Philippines

Infantry Division Command Post

ONE UNIT of a gun director. Telephone communication between directors and artillery batteries is of prime importance

Armored Forces
Division
Command Post

LEFT: Receiving a message in a radio hut on a Pacific island

RIGHT: Switchboards in a communications dugout in the Pacific theater

Infantry Regiment Command Post

Divisional Artillery Command Post

Armored Forces Combat Command Post

A COMMAND POST message center in Hollandia

Infantry Battalion Command Post

Artillery Battalion Command Post

THIS radio set was brought ashore and put into operation during a landing on Butaritari Island

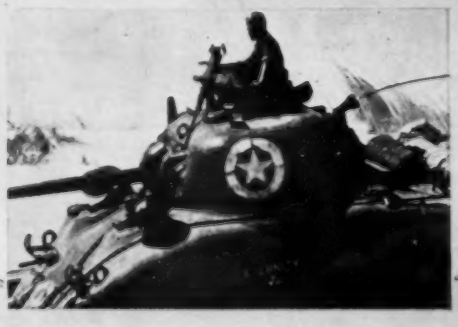
IN A dugout shelter in New Guinea these Signal Corps men test telephone circuits with others who are outside "shooting trouble"

Infantry Company Command Post

Armored Battalion Command Post

BEHIND the wreckage of a Japanese plane, Americans direct artillery fire from a shell-hole command post on Iwo Jima

Artillery Battery Commander and Gun Crew



Tank Company Commander

THE telephone switchboard makes this cave the nerve center of Vella Lavella Island

Artillery Observation

IN THE early stages of the bloody struggle for Iwo Jima a shallow foxhole gives scant shelter to the communicator calling for artillery support, while at the right, telephone wire is carried forward under fire

Infantry – the Front Line

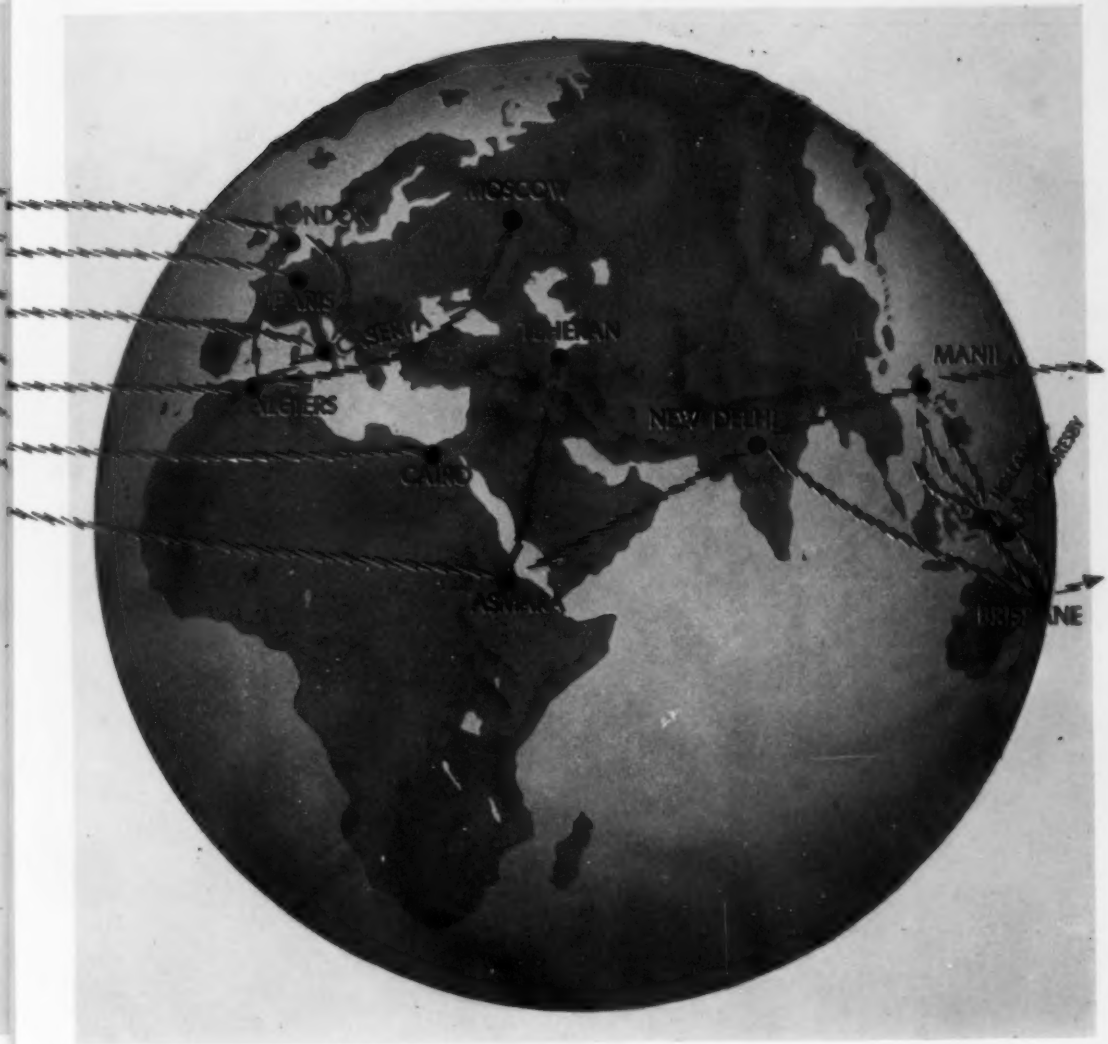
Tanks in Action

The Army Command and Administrative Network

THE PERFECT CONTROL and coördination of all military elements of this Nation's fighting forces on far-flung battle fronts is a vital factor in achieving victory.

The War Department communications networks, through which this control and coördination are accomplished, cover the United States by wire, and spread out by radio to the headquarters of all overseas theaters of operations, making connections there with many other smaller networks which may reach into every tank, plane, and lonely outpost.

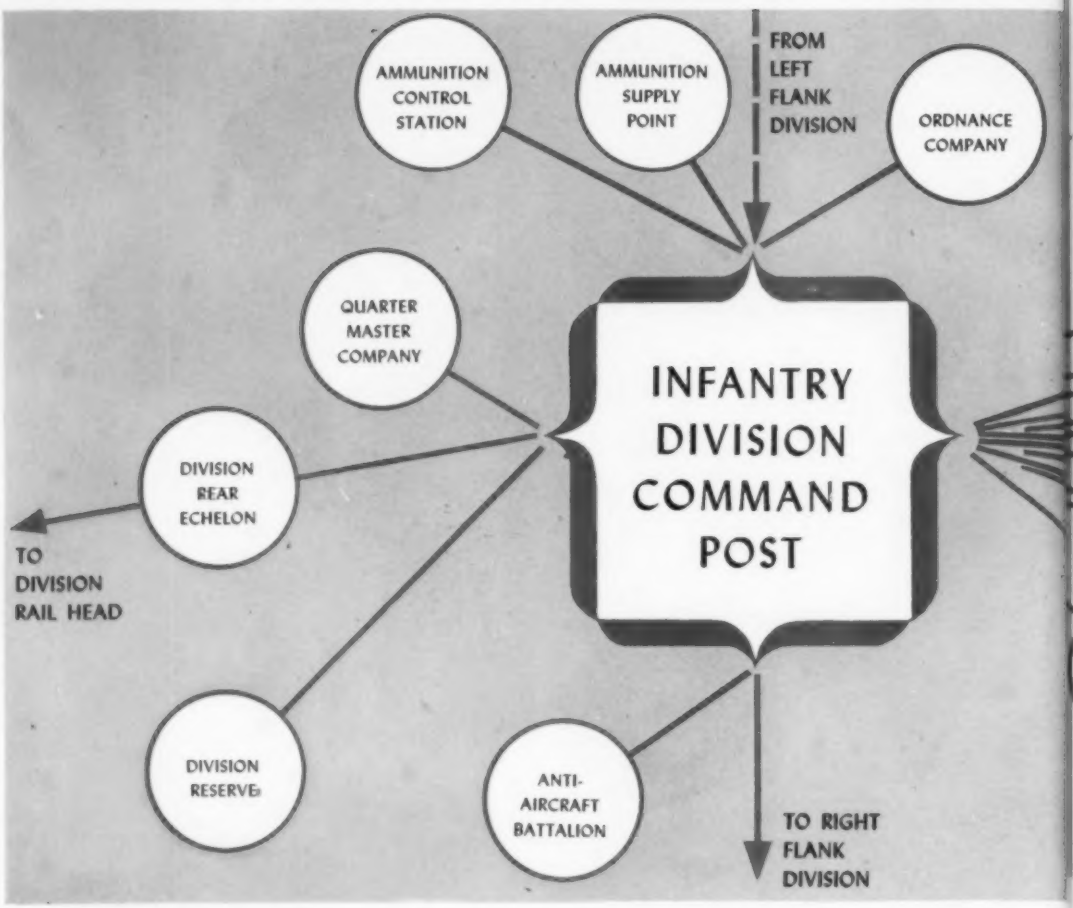
The backbone of this gigantic system is the Army Command and Administrative Network, installed, operated, and main-



tained by the Army Communications Service of the Signal Corps. More than 50,000,000 words per day have flashed over its circuits—tremendous volumes of highly important military and diplomatic traffic on which may depend the success or failure of the war, the lives and welfare of the soldiers, the very security of our country.

The Nation's inventive genius, engineering skill, and electrical resources were pooled in the creation of this integrated world-wide system. Possibly the most significant single development was the placing of communications on virtually an automatic basis, eliminating the old dot-dash method of transmission. Messages converted into strips of perforated teletypewriter tape may be relayed swiftly and efficiently from land line to radio and back to land line. Recently, in a demonstration of flexibility, Army Communications Service sent a nine-word message completely around the earth, through four automatic relay stations, in 9½ seconds.

On these two pages are shown the principal radioteletypewriter circuits which make it possible for the high command in Washington to maintain immediate and intimate contact with all overseas commanders.



How War Consumes Telephone Wire

A TYPICAL infantry division's normal supply of telephone wire when it goes into combat exceeds 700 miles.

Wire must move with the troops. Often there is not time to recover it after a position has been held for a period. So a fresh supply of wire is needed for each move.

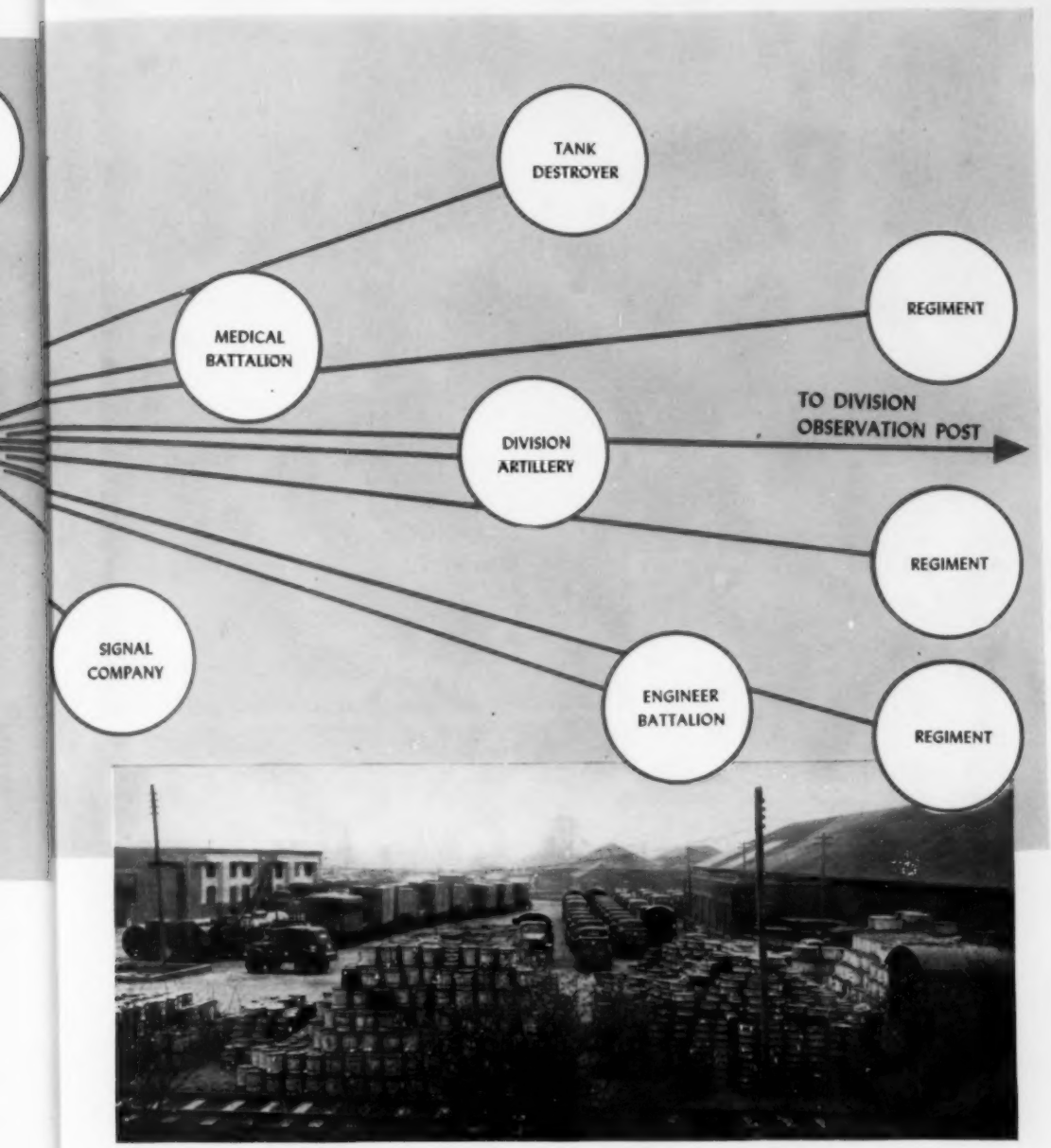
And while a division is in position, the enemy tries by every means possible to disrupt and damage its communication lines. Many miles of wire are lost to such action, and cannot be re-used.

As soon as an infantry division command post is established, one or more wire circuits fan out as quickly as possible to the units listed on the opposite page.

The majority of these channels are trunk circuits terminating in switchboards from which there may be from four to forty extensions. An infantry division, including the usually attached units, has about 70 switchboards which serve more than 550 field telephones.

There are still further ramifications. From division artillery, for instance, two lines must go to each of its four field division artillery battalions. In turn, each battalion must have wire communication with its three gun batteries, and with forward observers, and with infantry regiments.

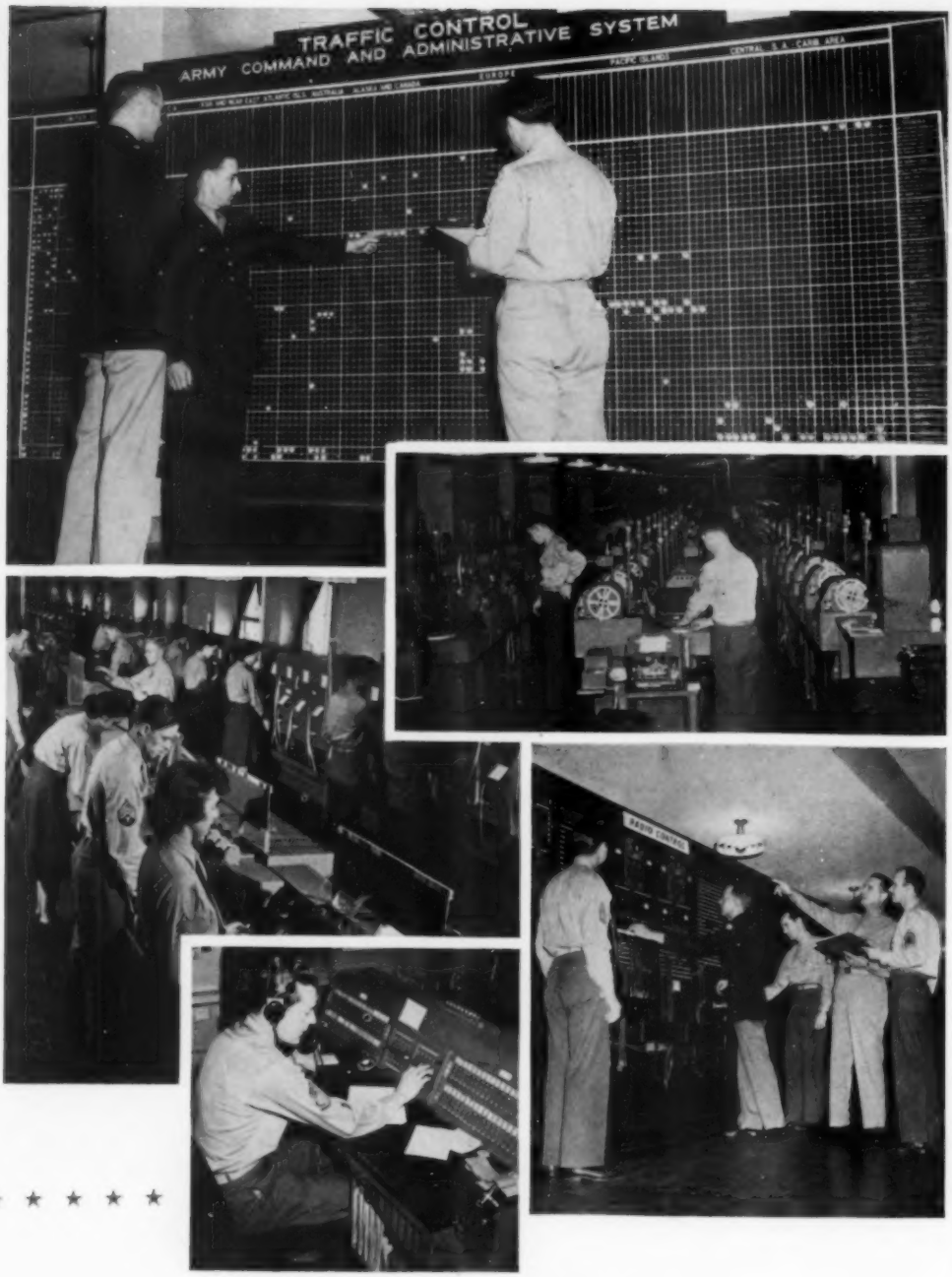
THAT is the average wire requirement of a single infantry division. Thought of in terms of all divisions, of all arms, of all theaters, it gives some understanding of how war consumes telephone wire.



COMMUNICATIONS MATERIÉL at an overseas supply depot

From An Infantry Division Command Post, Wires Run To—

Each of three infantry regiments, distance 5 to 20 miles each
Division artillery, distance 2 to 15 miles
Division observation post, distance 5 to 20 miles
Engineer battalion, distance 5 to 20 miles
Ammunition control station, distance 5 to 15 miles
Division reserve, distance 5 to 15 miles
Right flank division, distance 1½ to 4 miles
Rear echelon, distance 5 to 40 miles
Through rear echelon to railhead, distance 5 to 20 miles
Quartermaster company—Signal company—Ordnance company—Medical battalion—Traffic control stations
Attached tank destroyer battalion, distance 5 to 20 miles
Attached anti-aircraft battalion, distance 5 to 15 miles
Other attached units



★ ★ ★ ★ ★

Station WAR

THE War Department Signal Center is the key station in Army Communications Service's world-wide system. More than 9,000,000 words of war flow daily through this ultra-modern center, connected by wire with military installations throughout the United States, and by radio—through giant remotely-controlled transmitters and receivers—with all overseas theaters of operations. Shown here is some of the equipment which permits the speedy and efficient handling of so great a volume of messages.

Major General Harold M. McClelland

II. *In the Air*

By Major General Harold M. McClelland

CHIEF AIR COMMUNICATIONS OFFICER, HEADQUARTERS
ARMY AIR FORCES

DEVELOPMENT of the many types of Army Air Forces communications facilities, embracing radar, radio, telephone, and teletypewriter, has been a vital factor in the development of our air superiority.

From the beginning of the war, air communications have been called upon more and more to perform such vital tasks as guiding our aircraft to their targets, identifying those targets, locating enemy planes, and supplying our aircraft with the proper navigational aids to make safe returns to their home bases. Exploration of all the ways of accomplishing many seemingly impossible tasks has, in a few short years, developed an air communications system unequalled by any other military power.

The vast communications facilities of the Army Air Forces encircle the world. If they were visible, they would appear as a great web around the earth. Through this system, operational, tactical, and administrative information is sent and received by our innumerable fighting units.

There are more than twenty pieces of communications and electronic equipment in a single heavy bomber. With the employment of special devices, our forces are capable of seeing the enemy at night or through clouds, and are able to identify bombing targets even in the worst weather conditions. Through the use of this and other early warning equipment, our forces are alerted to the opposed planes and ships. This integrated communications system also distributes weather information urgently needed for the planning of all air operations.

In the Army Air Forces more than 400,000 of the Army's personnel are required for the operation, supply, maintenance, training, procurement, and storage of this communications equipment. The magnificent skill, effort, and loyalty of these men and women are attested by the flight of every plane that cleaves the air and by the achievements of the AAF in every theater.

Army Air Forces Communications

ESSENTIAL to the operations of the Army Air Forces are electrical communications: in the air, on the ground, and between ground and air. While it is unlikely that all the actions depicted below would ever take place within view of a single observer, the composite sketch illustrates in small compass the uses of many of the important systems of communications and items of equipment which contribute to the military success of the AAF. Among them are:—

Instrument approach system for aircraft

Air-sea rescue communications, for the rescue of flyers forced down at sea

Communications and radio navigation for airborne landings

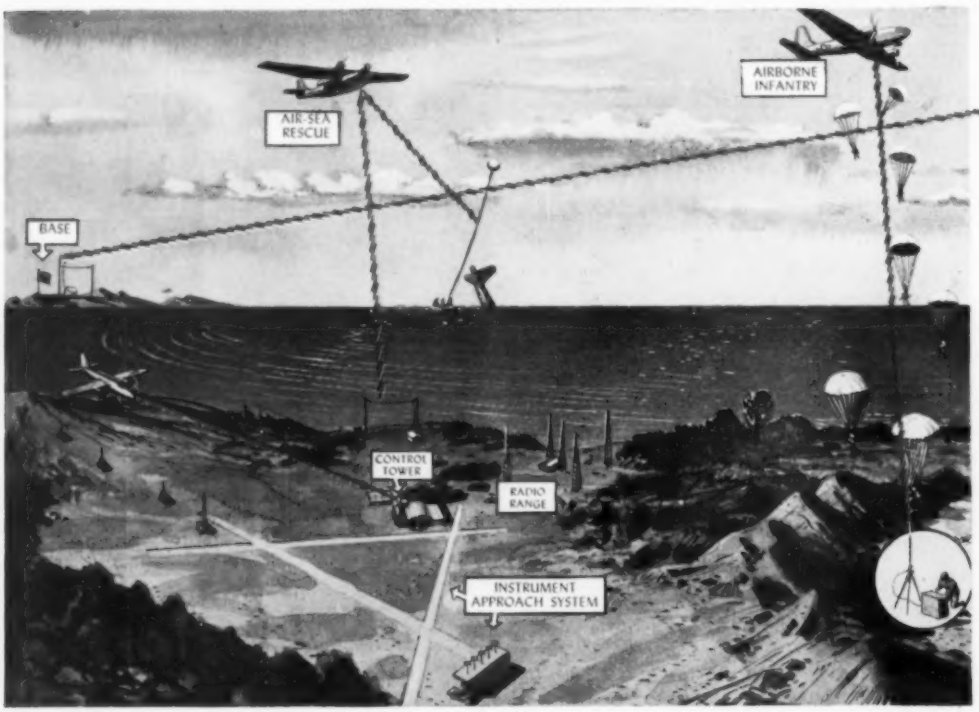
Strategic bombing communications with bomber base and with protecting fighter escort

Tactical bombing of and firing on enemy forces

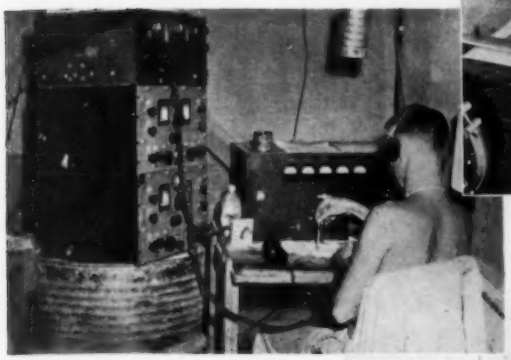
Control by radio communications of fighters against enemy aircraft

Long-range radio navigation system for the use of aircraft flying great distances

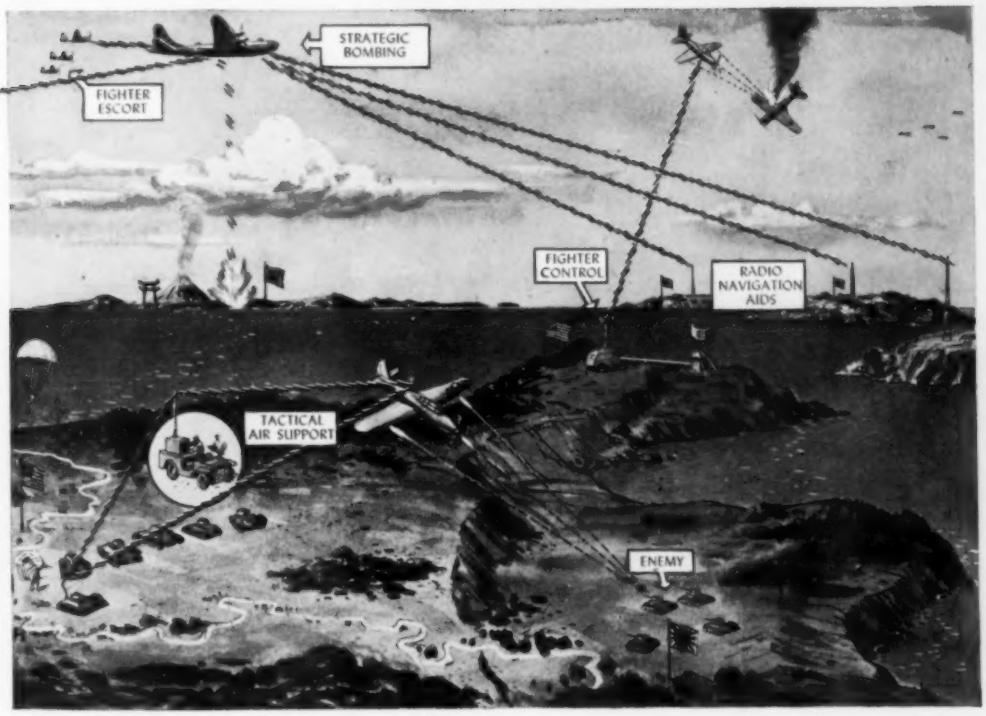
ABOVE: Coördination of air and ground forces at the front is often accomplished by such small units as this



THE radio operator of an Army transport plane maintains the all-important link with the ground stations



ABOVE: Make-shift facilities have been used to set up radio communication quickly at many a newly won airstrip. Right: An air coöperation installation such as this provides weather information and directs air support during an advance



Army Airways Communications System: Nerve System of the AAF

THE U. S. Army Air Forces—among other jobs—operate the world's largest air transport system. To guide the planes on their courses and maintain constant contact with them, radio highways in the sky stretch over the earth, along all the military air routes, and right up to the battle fronts. This globe-encircling network is operated by the Army Airways Communications System.

Many thousands of men, scattered in 1,000 small detachments throughout 48 states and 55 foreign countries, operating millions of dollars' worth of radio, telephone, and teletypewriter equipment, are required to perform this immense task.

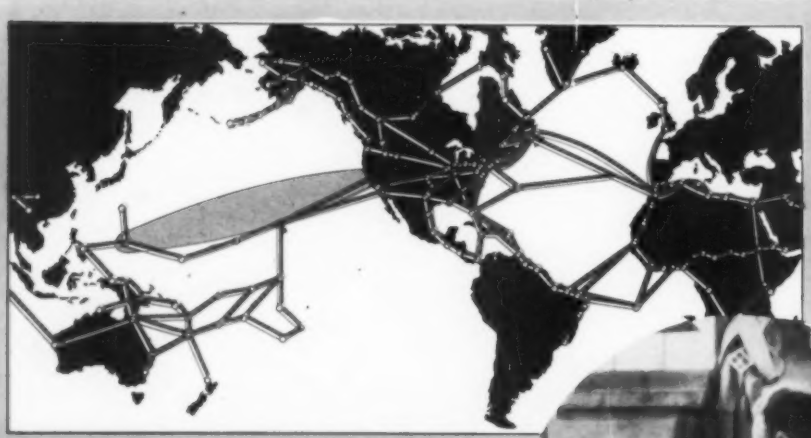
Messages concerning aircraft movements are flashed from airbase to airbase, never permitting a plane to come in "unannounced."

AACS point-to-point stations transmit weather information with the speed of light from the far reaches of Greenland or the south Pacific to the stations that information affects.

Position reports, radioed to AACS ground stations by airborne operators, are quickly relayed to the ship's home base, where a constant chart is kept on the plane's progress.

Hundreds of radio ranges, commonly called "beams," and homing beacons and other electronic navigational aids dot the globe, guiding AAF airplanes through fair weather and foul.

AACS men sit out their lonely vigils in



It's 5,000 miles from San Francisco to Saipan.

Requisitions for planes and crews are filed to the United States from a Pacific base over the operational and administrative point-to-point circuits of AACS.

direction-finding stations scattered in remote areas, not only to plot the position of some lost plane but to keep hourly check on flights over spots once regarded as the most difficult to navigate.

Instrument-landing crews constantly adjust their equipment and silently "sweat it out" as a plane breaks through the overcast over the runway, guided to earth by the radio paths transmitted by their equipment.

The men of the Army Airways Communications System have rewarding knowledge of airplanes and crews saved by their communications facilities, as well as of the routine and uneventful flights which build up such staggering figures as these:—

Every 15 minutes a military plane takes off for a flight across the Pacific. Every 13 minutes one takes the air to cross the Atlantic. Every 2½ minutes, during peak traffic periods, a cargo plane crosses the fabulous "Hump."

If all the radio navigational aids operated by AACS were placed equidistant around the 25,000-mile girdle of the equa-

IN lonely stations such as this in the China-Burma-India theater, AACS men keep their vigils the world around

Weather reports come from Baffin Bay, Dayton, Attu, Hawaii, Iwo Jima, and many another distant point over AACS circuits for the pilot's information as he plans his flight.

AN AACS maintenance chief checks radio transmitters at a busy communications center

tor, they would constitute a continuous radio highway with a radio range or homing beacon every 80 miles.

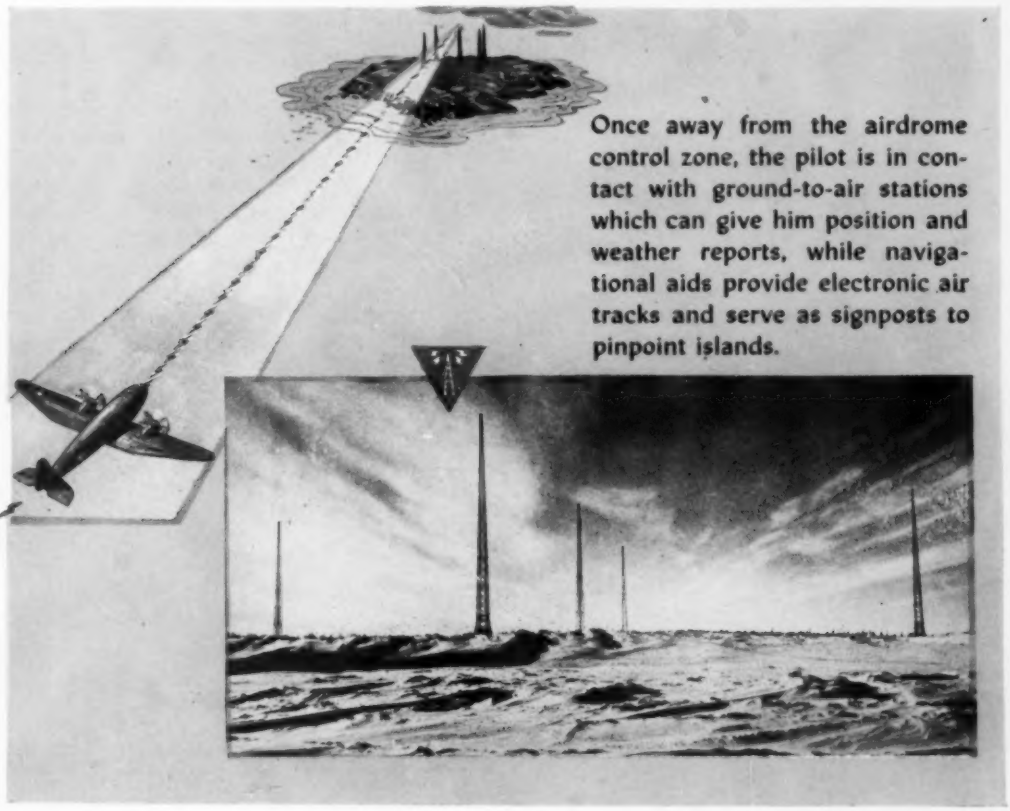
Other statistics are equally impressive. More than 300,000,000 words a month are transmitted by point-to-point stations. Ground stations make more than 50,000 "contacts" with planes in flight each day, and control tower operators, controlling landings and take-offs at air bases from Iwo Jima to Paris, made more than 4,000,000 "contacts" a month.

The prime function of the Army Airways Communications System lies in the provision of necessary radio facilities to guide aircraft along military air routes. But it is not all uneventful. Operating "JACSPAC," the joint communications system for the Army and Navy in the Pacific, AACS detachments have put equipment on beachheads while shells and mortar fire picked at the ground. During dozens of consecutive amphibious operations in the Southwest Pacific, AACS men have moved in under fire.

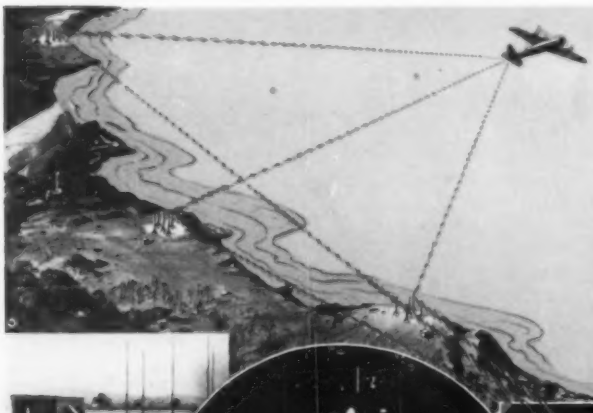
In the battle of the Pacific, with its long supply lines and watery air routes, it would be difficult to over-estimate the importance of the part played by the communications facilities provided by the Army Airways Communications System, "the nerve system of the AAF."

Communicating with the pilot by radio telephone, AACS control tower operators at busy AAF air terminals around the world direct the landing and take-off of all planes.

An air-borne radio operator keeps in touch with AACS ground stations to receive weather information and report the plane's position


Once away from the airdrome control zone, the pilot is in contact with ground-to-air stations which can give him position and weather reports, while navigational aids provide electronic air tracks and serve as signposts to pinpoint islands.

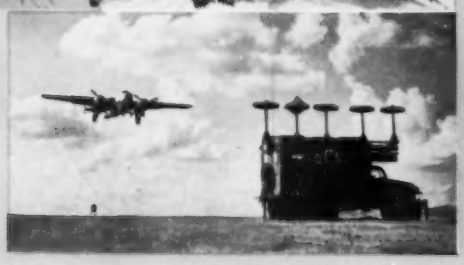
FROM this "elevated foxhole" on top of Saipan control tower the men controlled the take-offs and landings of B–29s while under Japanese fire



In huts on lonely islands and above continental beaches, direction-finder operators monitor the plane's radio signals, and each files the plane's bearing to an evaluation station where all are plotted and the craft's position is determined. This "fix" goes to the pilot by radio telephone, and to the air traffic control room.

FROM Burma to the United States, the men at the AACS control towers do their important jobs under all sorts of conditions

One of the latest electronic aids to air navigation, the instrument landing approach system guides the pilot "downstairs" through "weather" along a straight obstruction-free path of descent to the point of landing.

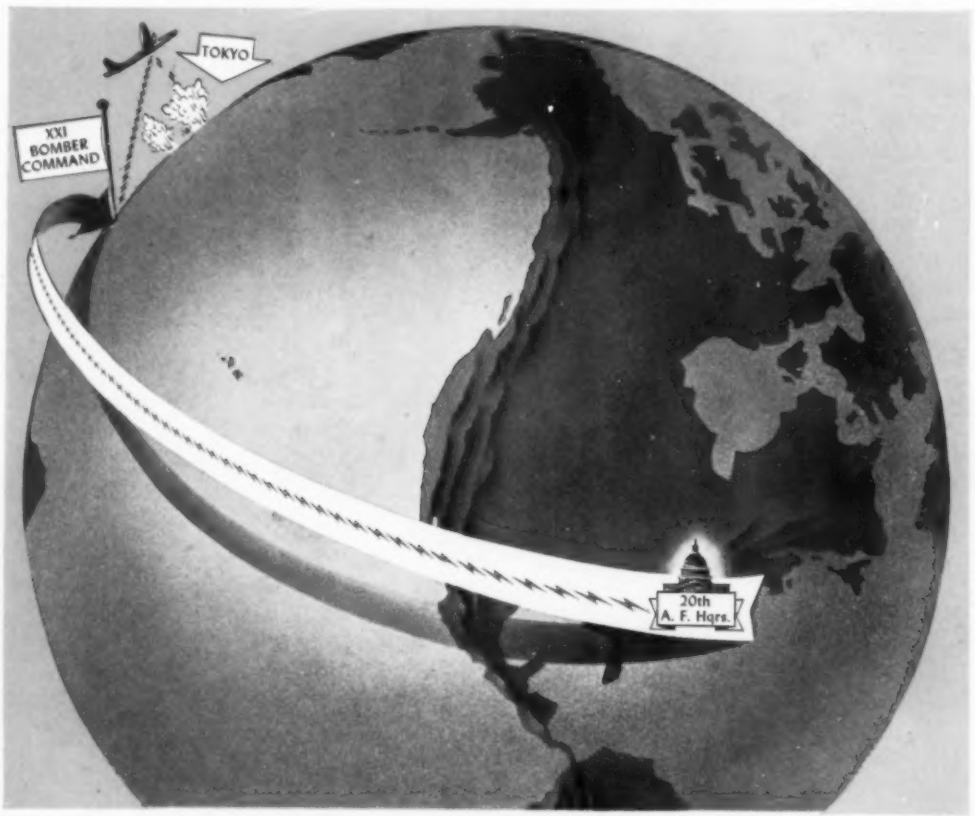


At the end of the flight, as at its start, the AACS control tower operator gives the pilot necessary information: correct order of landing, wind direction and velocity, and other facts needed for the safe completion of the trip. As the plane's wheels touch the ground, the tower operator reports "time of landing" to air traffic control.

Twentieth Air Force Communications

WHEN the bombardier of a B-29 releases his bombs over Tokyo, this fact may be known at the Headquarters of the Twentieth Air Force in Washington within four minutes—so swift and so direct is the communication between the planes of that strategic air force and the staff group which directs its operations across a distance of 9,000 miles. Organized as a strategic air force operating on a global scale, with its central headquarters in Washington, the Twentieth Air Force has developed its radio communications system to cover vast distances at high speed: point-to-point from Washington to the headquarters of the XX and XXI Bomber Commands in Asia and the Pacific; and air-ground between the bases and the B-29s—which fly the greatest ranges of any combat aircraft yet developed. Through these communications facilities, it is actually possible for Twentieth Air Force Headquarters to extend control of operations to B-29s in flight upon their mission of destruction against the enemy.

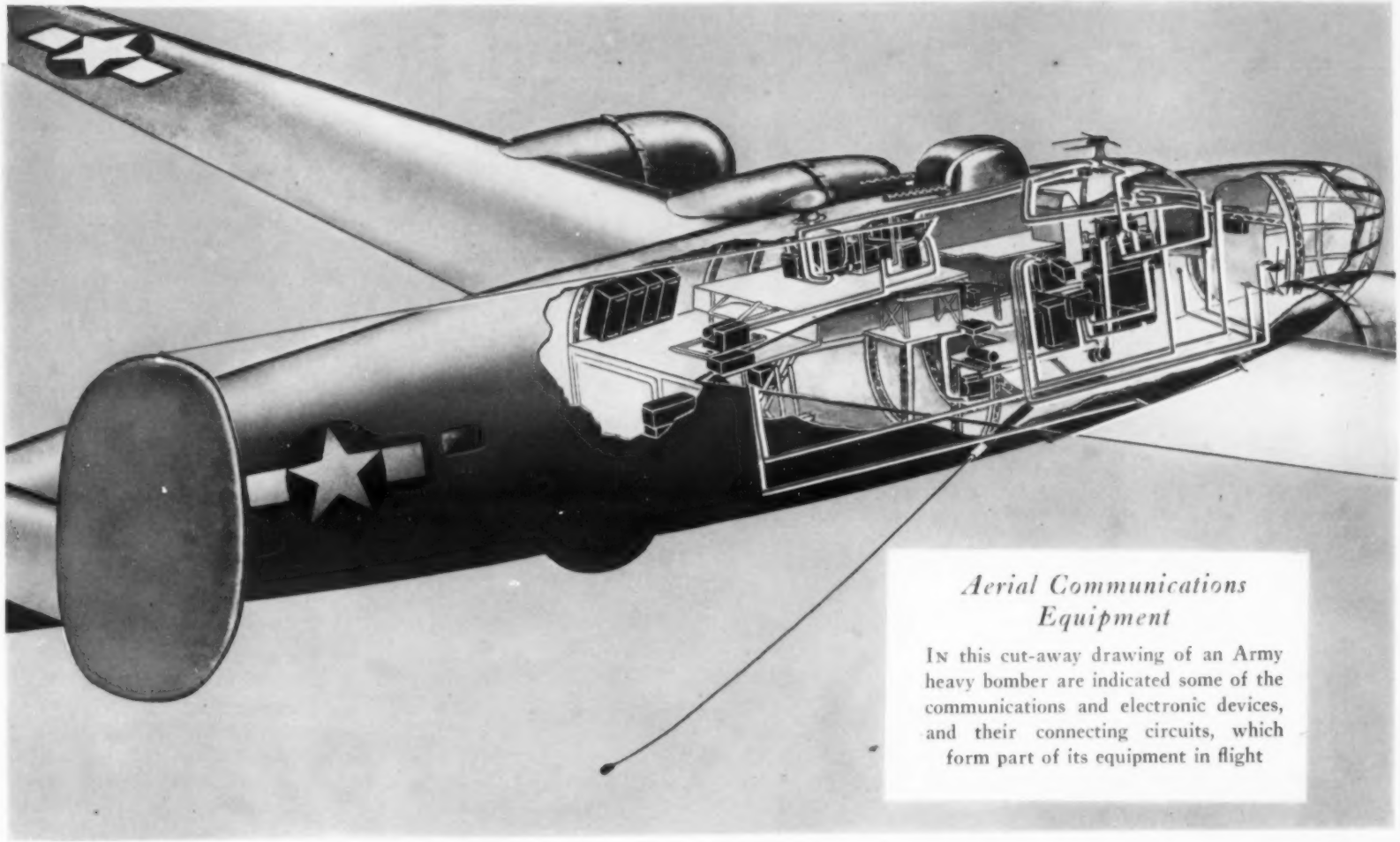
THE STINGER in the tail of a B–29



B–29s over Japan. Taken from the nose of a Superfortress on their first bombing raid over Tokyo, this picture shows the cone of Mount Fujiyama dead ahead

WITH pilot and co-pilot of this B–29 in their seats, the flight engineer, navigator, and radio operator are taking their places in the cabin

SUPERFORTRESSES of the 20th Air Force fly high and far above the clouds



Aerial Communications Equipment

In this cut-away drawing of an Army heavy bomber are indicated some of the communications and electronic devices, and their connecting circuits, which form part of its equipment in flight

Rear Admiral Joseph R. Redman

III. *At Sea*

By Rear Admiral Joseph R. Redman, USN

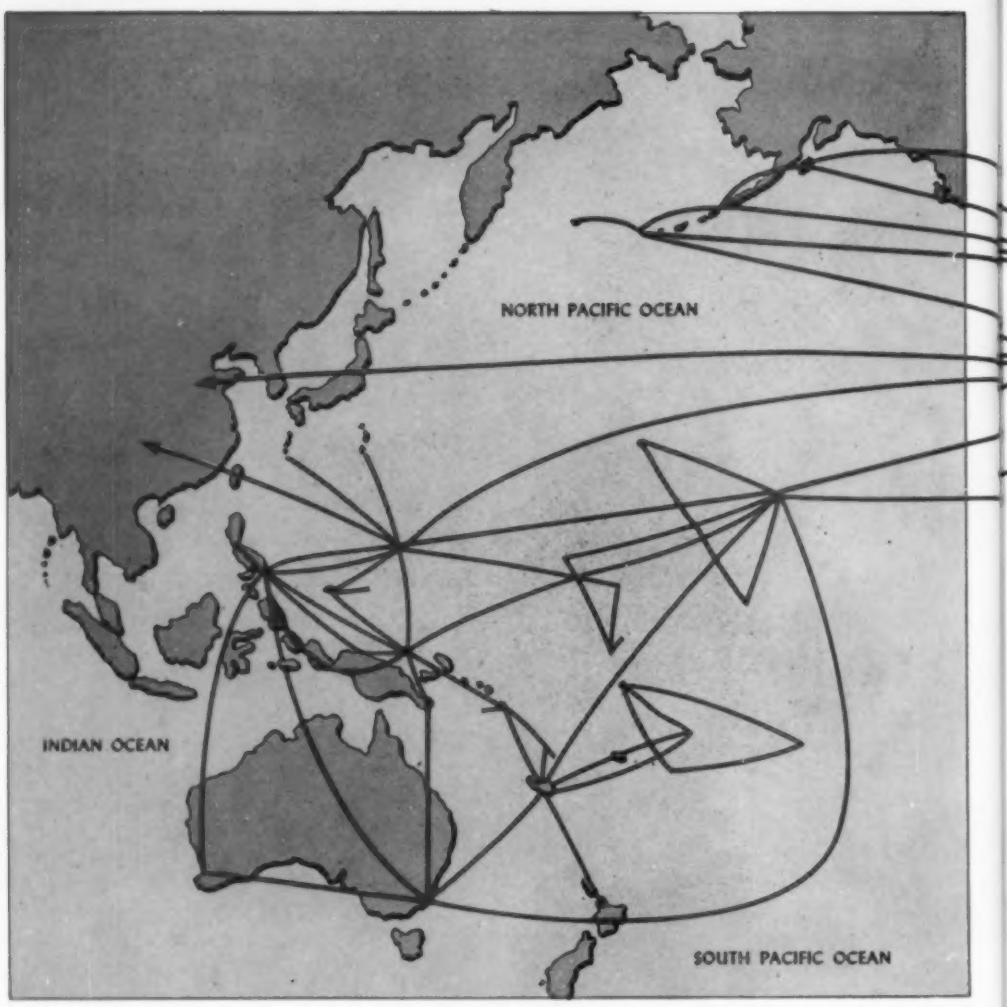
DIRECTOR, NAVAL COMMUNICATIONS

IN THE NAVY we have a particular need for a reliable, efficient, and lightning-fast system of communications, because our fighting units are ever mobile and must be capable of operating on all seas, however remote. That is why radio is such a vital factor in our communications, and why the Navy has played such an important part in pioneering and development in this field.

Between Naval shore stations and elements of the fleet, radio messages are transmitted which concern such vital matters as grand strategy and such important but routine affairs as supplies and personnel. By radio, an admiral has control of the disposition and tactics of the units of his fleet at all times. Between ships, when radio silence is not imposed, flash communications of many kinds. Carriers and their planes maintain contact by radio. Success of an amphibious operation, that most hazardous of undertakings, is dependent upon the coordination of action of hundreds of vessels, obtained largely by radio. And, once the beach-head has been won, radio provides the link between the invading forces and the supporting elements off shore. Due to the speed with which modern naval combat units operate, both in the air and on the surface, there is such a heavy demand for radio channels in mobile operations that top priority in the use of radio spectrum space is required. It is natural that this speed-up of mobile operations will carry over into post-war commercial activities when similar spectrum priority will be needed.

Proportionately, voice communication by wire telephone is less used; yet every vessel has its own system or systems of vital interior communication, ranging from elaborate dial installations to sound-powered telephones.

All these modern, highly developed methods of communication contributed much to the Navy's share in the defeat of Germany; and across the long reaches of the Pacific their part in the coming victory over Japan will be impossible to over-estimate.



MAJOR POINT-TO-POINT CIRCUITS OF

Fundamentals of Naval Communications

THE KEYNOTE of naval warfare is movement. Naval communications must be able to reach any point on the surface of the earth where ships or planes may go, and must be able to do so at all times without prior notice.

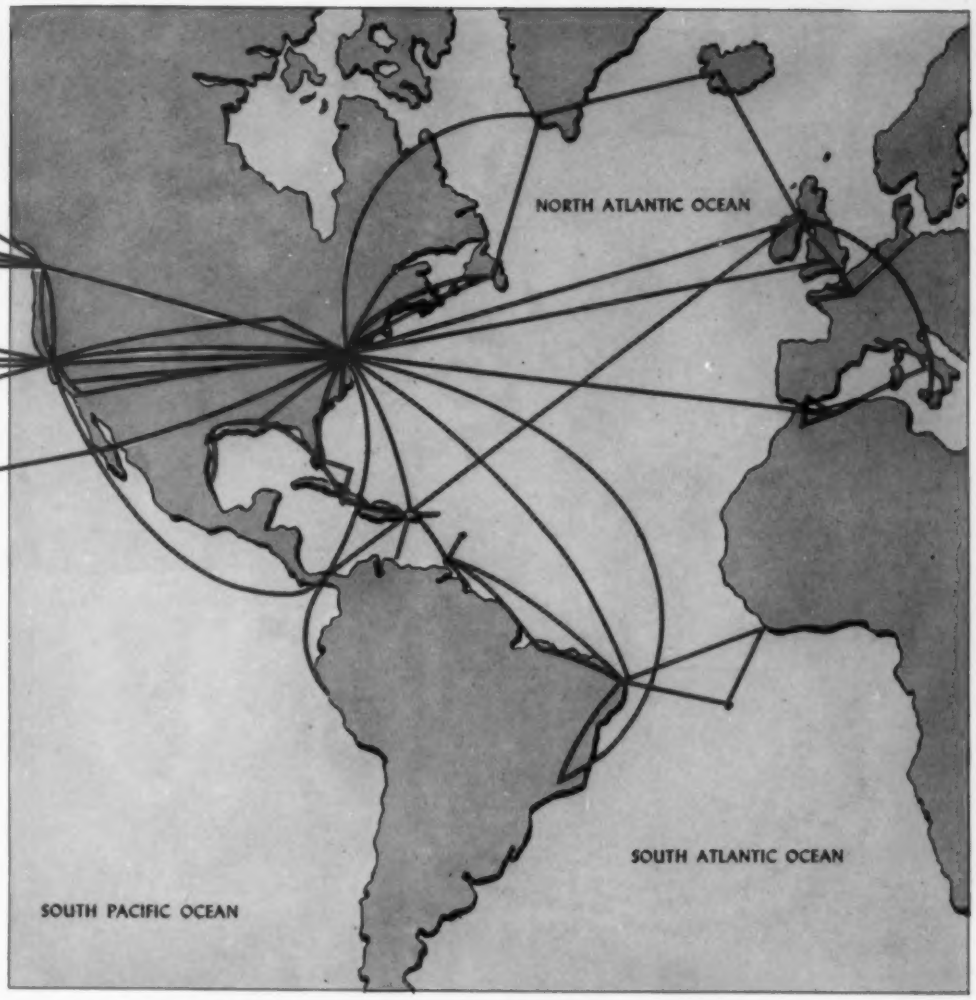
The solution of this problem, complicated enough, is made infinitely more difficult by the necessity to conceal the location of the point where the message is received. Apparatus to detect the location of radio receivers has reached a high degree of excellence and counter-measures must be equally good.

The entire naval organization has one purpose: to support the fleet. The requirements of the fleet govern the entire set-up of Naval communications, the design of equipment, the uses to which it is put, and the location of communication centers.

In so far as is possible, land wires are used in continental regions.

Full advantage is taken of multiple-channel improvements as these are developed. Both ashore and afloat, teletypewriter instruments are used whenever possible, and their numbers are increasing rapidly.

Advanced communications bases are



THE NAVAL COMMUNICATIONS SYSTEM

placed where needed to facilitate transmission to the fleet, wherever it may be operating. The need for such bases sometimes is unforeseen, due to the mobility of naval warfare, and often they have to be established at short notice.

The speed of communications has increased considerably since the war began. Research has produced numerous new means of electronic communications and has found new uses for methods already in existence. These are, of course, highly secret for so long as they may be of use to an enemy, but the entire world will benefit after the war by some of the developments introduced in Naval communications to meet the needs of the service.

These new means of communications have had a direct effect on the conduct of the war. To a considerable extent, it is due to them that task forces and fleets have been able to operate at sea for longer periods and at greater distances from bases than had been possible, or than is possible now for the enemy. No longer must the U. S. Navy strike and then return to base.

As the chart shows, the communications center of the Pacific at present is Guam. Besides the official messages transmitted over regular service channels, the news of the Pacific war reaches the people of the United States through that island. Four voice circuits are open to the press between Guam and the United States, and the messages sent over them are repeated by teletypewriter to insure accuracy.

LEFT: Instant telephone and radio communication is essential to the Navy's dramatic air-sea rescue operations

BELOW: Part of the radio transmitting installation on Guam, headquarters of Naval operations in the Pacific

Stations Ashore

IN THE European phase of the war there were existing cables, wires, and radio installations which might be utilized; but in the Pacific, most of the communication bases have had to be built from the ground up.

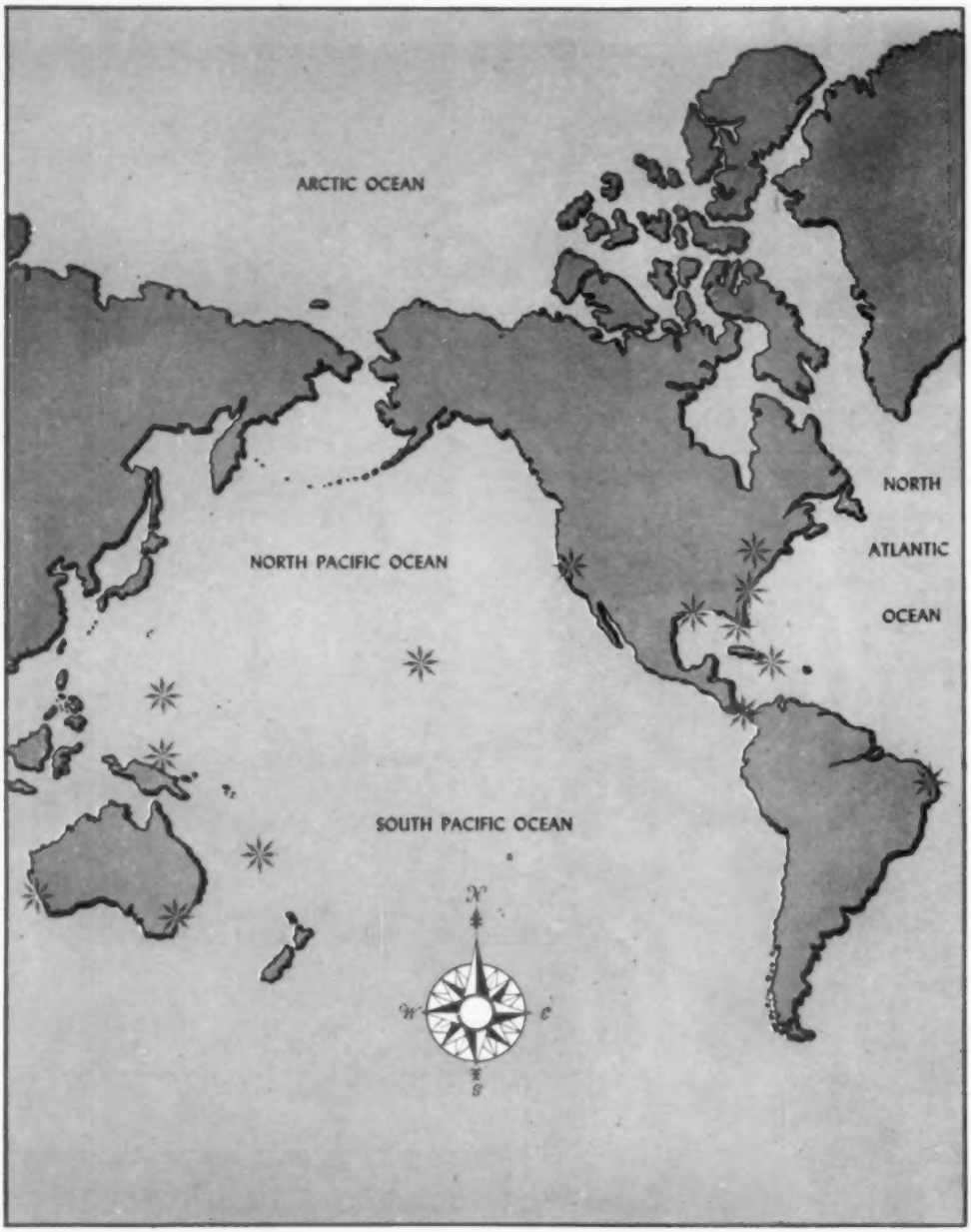
Naval communications men, working above and below ground from New Zealand to Alaska, have built a chain of stations which now approaches Japan itself.

These are the links between the fighting men and the people at home.

ELECTRICAL communications save Navy outposts from complete isolation in the bleak Alaskan winter

A RADIO installation is erected in a jungle clearing on a Pacific island

A SIGNALMAN (left) strings telephone wire in the Pacific; and (below) Marines operate radio equipment in a communications office of a Marine Air Group



NAVY RADIO BROADCASTING STATIONS

For Silent Ships

SHIPS of the Navy must receive instructions and information at all times, but often they themselves must maintain radio silence for days and weeks on end. They cannot acknowledge messages received, however important.

For such circumstances, flow of communications to the ships must be absolutely sure.

The chart above indicates the network of stations which provides this service, one of the most vital to the Navy.

PARADE OF POWER

AIRCRAFT CARRIERS, battleships, and cruisers, part of the Third Fleet. Below: a battlewagon in silhouette

EARS OF THE NAVY

This is the central radio receiving room of a battleship

Between Ships at Sea

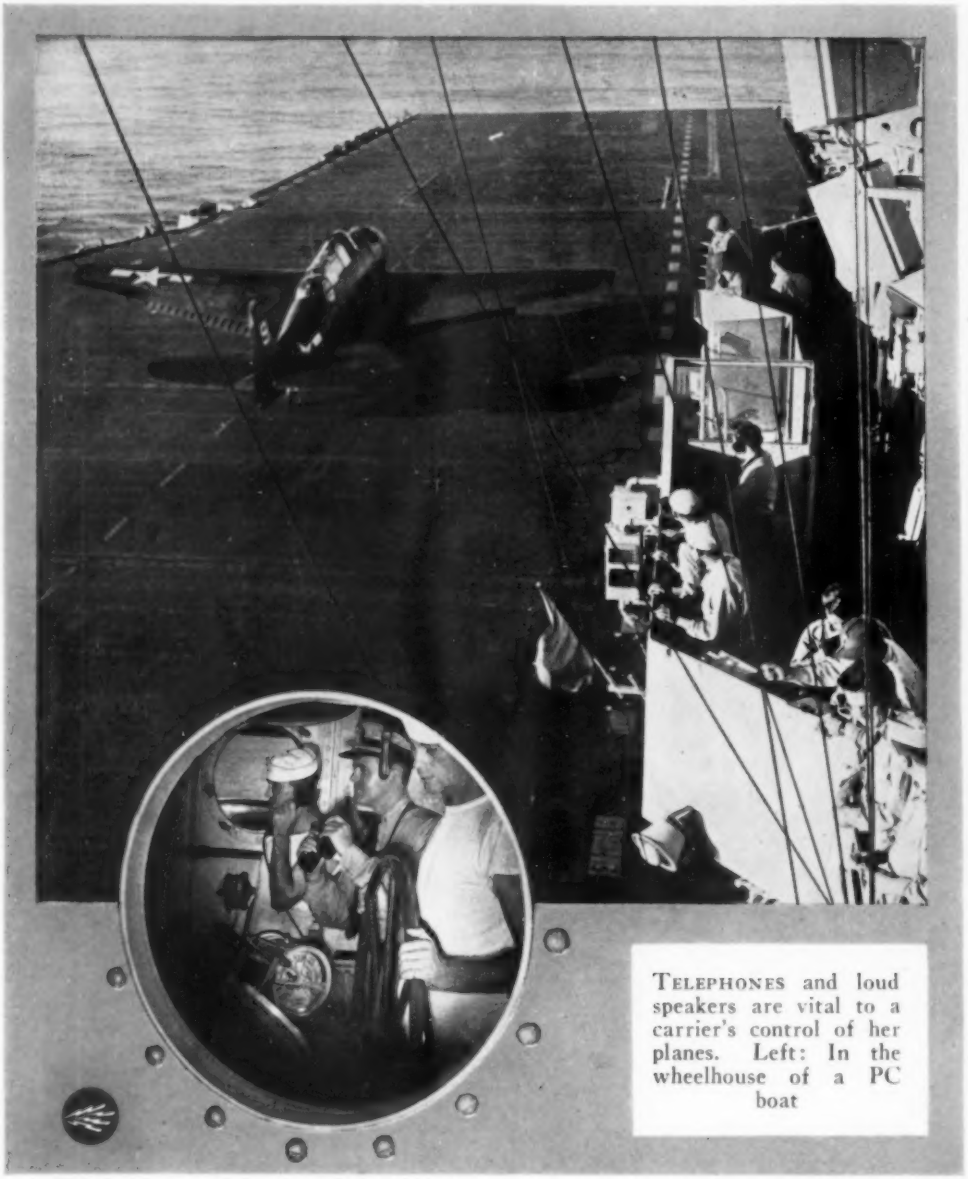
BETWEEN ship and ship, and between ship and shore, ordinary radio cannot be used for considerable periods, to prevent the enemy from detecting the location of forces afloat.

Great ingenuity guards the secrecy of communications at sea. That these methods are effective is indicated by the number of times that the enemy has been surprised. Ultra-short wave is used for tactical control of ships.

A modern carrier has 101 radio circuits, a modern battleship 77, even a torpedo boat has seven.

THE pilot talks by telephone with his tail gunner (above) as well as by radio with the carrier. Below: Receiving a radio message aboard a speedy PT boat

ABOVE: Pilots aboard a carrier listening to inter-plane conversations of fellow pilots in action against the enemy



TELEPHONES and loud speakers are vital to a carrier's control of her planes. Left: In the wheelhouse of a PC boat

On Shipboard

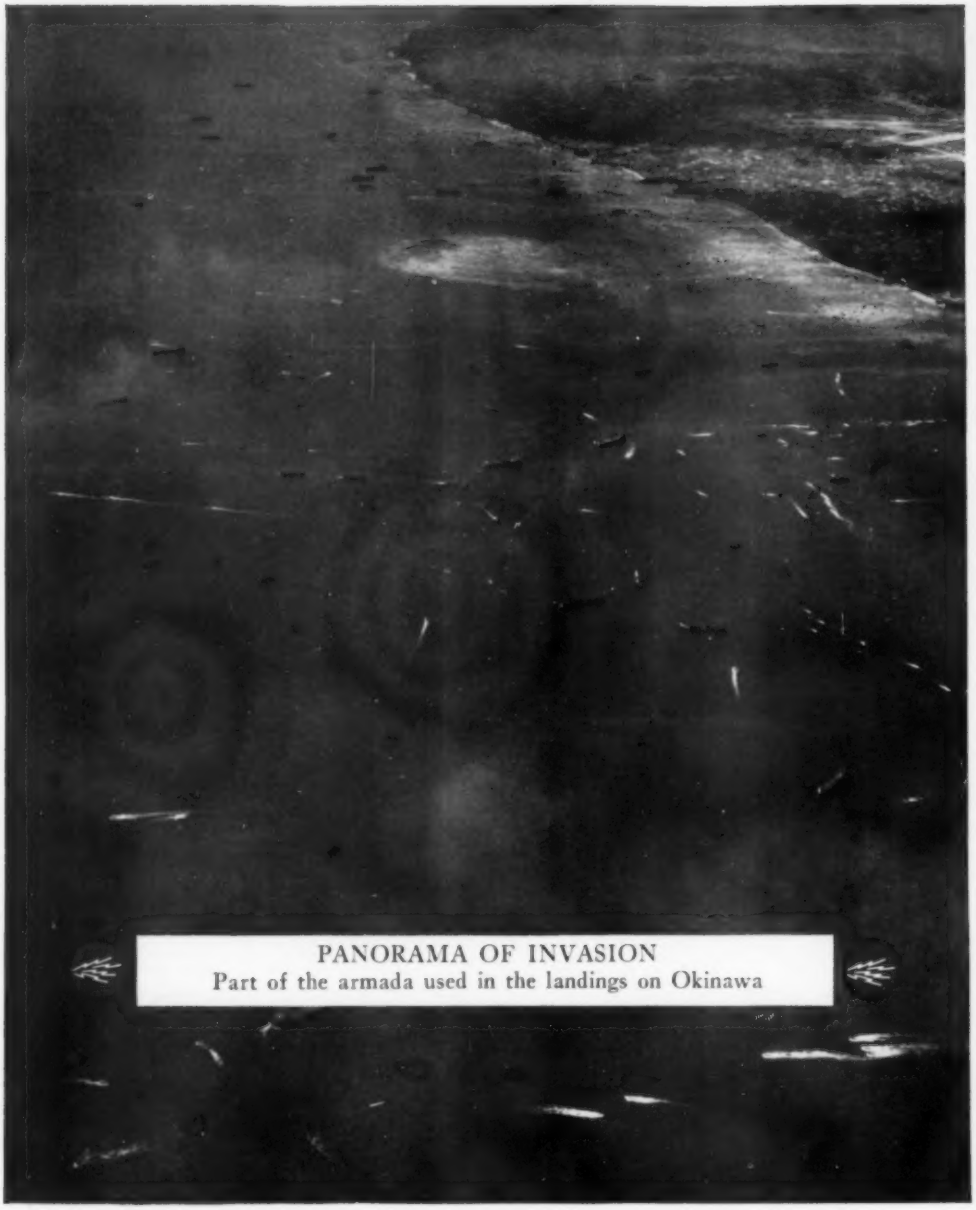
TELEPHONES aboard ship, vital to interior communications, range from the glamorous "Admiral's phone" to the multitude of sound-powered instruments linking action stations and command positions.

The dial system of a battleship is similar to that of any large city. A commanding officer may be instantly in touch by telephone with any of his staff. Sound-powered telephones, besides needing no electrical power, provide conference communication: for example, a gunnery officer can speak to all the gun crews under his control simultaneously.

A single battleship requires about 2,000 instruments. The hand-sets already produced for the fleet approach the total civilian installations of Washington, D. C.

A SIGNAL OFFICER on a carrier orders a pilot to cut his throttle for a landing. Below: A sound-powered quarterdeck telephone

Above: Piping the crew over the loud speaker system. Right: A chaplain describes an aerial action to the ship's company



PANORAMA OF INVASION
Part of the armada used in the landings on Okinawa

Amphibious Operations

COMMUNICATIONS are the core of amphibious operations. It is necessary for hundreds of surface craft and aircraft to perform tasks specified for each on a schedule laid down to the minute, and this must be done despite weather and the enemy.

All forms of communications—electronic, visual, and voice—here are in use at once in a small area. The commander afloat receives exact information of what happens on the beach in order to regulate the conduct of the operation, the control of supporting naval gunfire, and the order in which men and material flow into the action.

ABOARD a Coast Guard vessel, communications men keep in touch with operations ashore. Below: Marines set up radio equipment on a recently captured beach

THESE MARINES are awaiting word that another telephone line is hooked up on a Pacific island. Right: With his handy-talkie, this Coast Guardsman helps control traffic to and from a busy island beach

PLANES OF "NATS"
They fly precious cargoes far over lonely waters

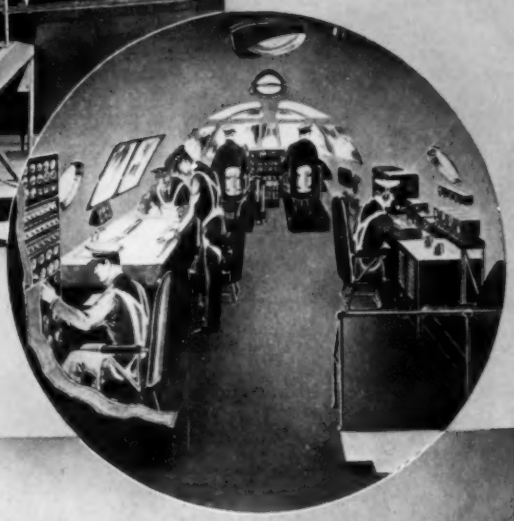
Naval Air Transport Service

THIRTY DAYS after Pearl Harbor, the Naval Air Transport Service began with three aircraft. Today nearly 450 planes move high-priority freight and personnel all over the world.

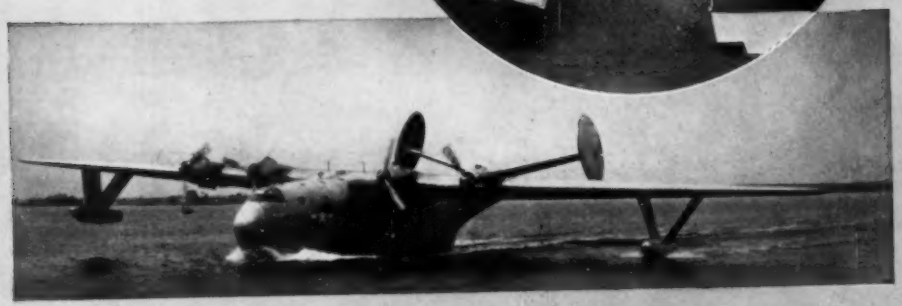
To carry out this task, a system of communications is vital, and NATS has its own which has grown as the areas of combat have spread. It must be possible to reach every base and every plane at all times over routes which cover 65,000 miles.

Among the manifold duties of the Naval Air Transport Service is the movement of wounded from the battle zones to hospitals in the Pacific, and from the hospitals to the United States.

WAVES operate many Naval Air Station control towers. Left: bringing the wounded back to hospital



BELOW: The NATS flying boat MARS; and, right, a sketch of the plane's interior



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Navy Communications Center

THROUGH this Navy Department communications center passes the direction of this nation's Naval warfare. It is the heart of all Navy communications. Through it, at any time of day or night, the Navy Commander in Chief can reach, directly or indirectly, any station, any officer, any vessel in any part of the world. More than 5,000 Waves are assigned to communications work.

Improvements in Speed of Service, Accuracy, Uniformity, Dependability, and Economy Will Result When Toll Calls Can Be Dialed Straight to the Called Telephone

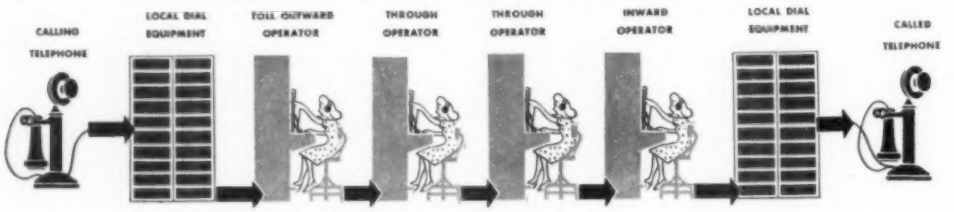
Operator Toll Dialing—A New Long Distance Method

James J. Pilliod and Harold L. Ryan

WITHIN the next several years following the end of the war, methods and equipment will be available which will enable Bell System long distance operators to dial calls, directly and unassisted, straight through to the called telephone even though it be at the other side of the continent. Assuming the completion of the System's local dial service program during the next decade, this means that by about the end of that period a call from any telephone in the System may reach practically any other telephone anywhere in the country, swiftly and accurately, through the services of just one operator. The plan is sufficiently comprehensive to provide for the inclusion of offices of independent telephone companies which desire to participate.

Two developments now under way, among the many factors involved in a project of such importance and great scope, will be the principal contributors to the accomplishment of System-wide toll dialing. One of these is a new system of toll dial switching equipment which functions, in response to the operator's dial, with uncanny discrimination, accuracy, and capacity for performing many operations economically. The other is the toll dial operating method itself—of which an important element is a nation-wide numbering plan which may be universally used by all outward long distance operators to complete a call to a telephone reached through any central office connected with the nation's toll network.

Operator toll dialing offers impressive opportunities for further improvement in the speed of long distance connections, in the accuracy and reliability of the service, and in overall economies of operation. To appreciate how long distance service will go ahead in the next several



DIAGRAMMATIC representation of manual toll operation. The operators in different cities are linked together by toll circuits

years, it may be helpful to recall how far it has come in the last twenty-five.

Operating Methods: Past and Present

TWENTY-FIVE YEARS AGO, the average speed of service on long distance calls was 14 minutes. By 1940, the year before the war, it had been reduced to 1.4 minutes. Along with this improvement in the speed of service, clearness of transmission has been increased, and rates have been reduced 30 percent on the average—and more on the longer hauls. In 1920, it cost $16.50 to make a station-to-station call from New York to San Francisco; now it costs $2.50.

THE SEPARATE LINE AND RECORDING METHOD

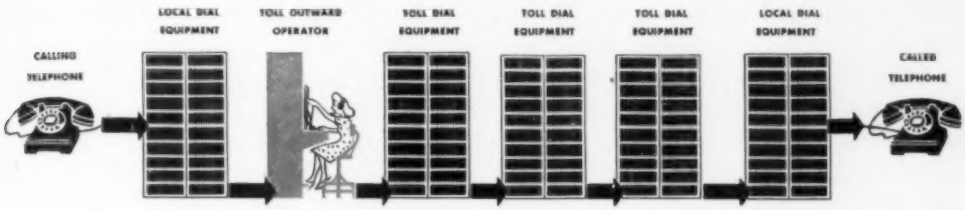
IN 1920, the System was almost wholly manual, and long distance calls averaged only about 700,000 a day. In making a long distance call, the customer lifted his telephone receiver and asked the local "A" operator for "Long Distance." She connected him with a toll recording operator, who recorded the details of the call on a toll ticket and then said to the customer, "Thank you. I will call you."

The ticket was then sent by messenger—or in some of the larger offices by pneumatic tube—to the toll outward operator. She picked up the customer's line through a "B" operator in the local office, selected a toll line, rang, and—in the case of a switched call—asked each successive through operator for the called place until the inward operator at the terminating point was reached. She then asked the inward operator to connect to the called telephone, which the latter did through the local "B" operator. It was necessary for the outward operator to remain in on the connection until the answer at the called telephone and the start of conversation. In general, the establishment of a two-switch connection by the single ticket method involved eight operators and in most cases a messenger.

During the next five years, largely through more adequate circuit and equipment facilities, better maintenance, and improvement in toll office management, the time required to complete connections was cut approximately in half—from 14 to 7.3 minutes.

THE COMBINED LINE AND RECORDING METHOD

CONVERSION from the separate line and recording method of operation



DIAGRAMMATIC representation of operator toll dialing. The equipment in different cities is linked together by toll circuits

to the combined line and recording method, commonly called "CLR," started in 1926. By that time the conversion of manual offices to dial was well under way, and already about 15 percent of the System's telephones were dial operated. By 1935 they had increased to nearly 50 percent, and about two-thirds are now dial.

With the CLR method and dial service, the customer dials a code number and is connected directly to a toll operator who combines the recording of the call with the line work. This by-passes the local "A" and recording operators and the messenger. The customer is held at the telephone while the connection is completed—or the first attempt is made—thus avoiding recalling the customer. As under the former method, the line operator advances the call to the inward operator at the called place and the latter makes the connection directly to the called telephone by dialing, generally without the aid of the local "B" operator at the terminating point. Instead of eight operators and a messenger, as under the earlier method, only four operators are concerned with the completion of the connection on a two-switch call. The reduction is due in part to CLR operation and in part to the use of dial central office equipment.

Along with the introduction of the CLR method, considerable improvement also was made in transmission, and the number of switches required to complete calls was reduced through the introduction of the General Toll Switching Plan and the provision of the necessary circuit facilities to make it operative. This plan set up eight regional centers, at New York, Atlanta, Chicago, St. Louis, Dallas, Denver, Los Angeles and San Francisco—all of which are directly interconnected. To these regional centers are connected some 140 primary outlets throughout the country, and to these in turn are connected all the rest of the toll centers—some 2400. This makes it possible to complete a call from any toll center to any other toll center with a maximum of four switches.

Extension of the CLR method, improvement in transmission, reduction in the number of switches, better toll line engineering methods, and improved central office procedures for handling calls under the CLR method had resulted by 1930 in 82 percent of all long distance calls being handled while the customer remained at the telephone and in improving the speed of service to 2.1 minutes. The

public response to these service improvements was immediate.

The period from 1930 to 1935, the depression years, was utilized to develop to a high degree the "know-how" of handling toll board traffic; and as a result, by 1935, 92 percent of the calls were handled while the customer remained at the telephone and with an average speed of 1.4 minutes.

By 1935, also, practically full account had been taken of the speed advantages inherent in the combined line and recording method. Although marked improvement was made between 1935 and 1940 in accuracy and in the tone and manner in which service was rendered, no further improvement was achieved in the speed of service.

The Toll Dialing Method

OPERATOR TOLL DIALING is already in limited operation, more than 130,000 calls a day, or about five percent of the daily 2,700,000 toll board calls, being handled over Bell System lines by this method.

Briefly, under this method the customer dials the usual code to reach the outward toll operator, who in turn completes the call to the distant telephone through toll dial equipment without the assistance—in most cases—of another operator. The four operators involved in the completion of a two-switch call under the CLR method would thus be reduced to one if such a call were handled by the toll dialing method.

With this method, on a station-to-station call, the toll operator, after dialing the necessary codes and the called number, can cut out of that connection and proceed with other calls, since she will receive a signal when the called telephone answers or another signal if the called subscriber's line is busy. If the circuits are busy, she will receive a signal, and when a circuit becomes available another signal will tell her to dial again. Provision is made for the operator to reach toll inward, information, and other operators if their assistance is necessary in the completion of calls.

Before describing in detail how long distance calls will actually be handled under the proposed operator toll dialing method, however, it will be necessary to point out the principal features of the universal numbering plan, which is a necessary adjunct of the operating method.

THE UNIVERSAL NUMBERING PLAN

DEVELOPMENT of nation-wide operator toll dialing requires, as a concurrent step, development also of a nation-wide numbering plan and a simple scheme of destination codes for being able to reach any toll center in the long distance network and thus any central office and any telephone. Through this plan, the same code can be universally used by all outward operators for reaching any particular office, and this code is passed along by the equipment and re-used at all intermediate switching points. (Shorter-haul calls will continue to be completed without the use of the national toll codes.)

To set up this universal numbering plan, the country is being divided into from 60 to 75 numbering-plan areas. Each of these will be designated by a distinctive three-digit code. Each

office within an area will be designated by a three-digit office code, not conflicting with the code of any other office within the area nor with any area code. Thus each office in the country will be assigned its own distinctive six-digit code made up of a three-digit area code and a three-digit office code. In order to make this plan truly nation-wide in scope, provision is being made for the inclusion of independent telephone offices where desired by the independent telephone companies.

Any toll call can be completed by dialing a maximum of 10 digits: the six digits of the area and office codes and the four digits of the called telephone number. On calls between points in the same numbering plan area, the area code will not be required and only seven digits need be dialed. Area codes will contain the digit "1" or "0" in the first or second place, while office codes will never have those digits in the first or second place. This enables the equipment to recognize from the first two digits dialed whether a 10-digit inter-area or a seven-digit intra-area call is being made.

How the country might look when divided into approximately 60 areas for the nation-wide numbering plan

The accompanying map illustrates how the country might be divided into areas for such a nation-wide numbering plan. It will be noted that the boundaries of the numbering plan areas generally follow state lines. To the extent that it is feasi-

ble, an entire state will be included in one numbering plan area, so that the operator can readily associate the numbering plan code with the state name. Examples of this are the States of Washington, Maine, Connecticut, and New Jersey.

The larger states, such as New York, Illinois, Texas, and California, will be divided into two or more numbering plan areas each; and in some cases, such as North and South Dakota, it will be possible to combine two states in the same numbering plan area.

No change of customers' telephone numbers nor of local dialing practice is necessary.

For the three-digit office codes which designate the offices within a numbering plan area, and which will be non-conflicting, the first two letters of the community or office name plus a numeral will generally be used. These codes are for the use of toll operators only. For the seven-digit cities with two-letter five-numeral numbering plans for customer use, operators will use the same office codes as customers. It is anticipated that all seven-digit cities will be on this basis by the time the new routing system is widely adopted. For six- and five-digit cities, the code for the use of toll operators will be the existing office code with one or two added digits. For four-digit offices, the code will be three added digits.

On many calls, the entire routing code can be derived from the information furnished by the calling customer with reference only to very simple code information on the bulletin at the operator's position. For example, on a call from Fargo, North Dakota, to Newark, New Jersey, MArket 2-2100, the Fargo operator would determine from her bulletin that the New Jersey code is, say, 312 and would dial 312 followed by the listed number MA2-2100. On a call to Newark from Camden, New Jersey, both of which are within the same numbering plan area, the area code would not be required and the operator would simply dial the listed number MA2-2100.

There are numerous cities located near state boundaries which have close community of interest with places just over the boundary. Well-known examples of this are Philadelphia-Camden, New Jersey; Detroit-Windsor, Ontario; and Washington-Alexandria, Virginia. Wherever possible the area around such cities will be included in the numbering plan area of both the adjacent states. Central office code conflicts in the adjacent cities will be eliminated and this, together with their inclusion in both numbering plan areas, will make it possible for operators to dial across the state boundaries without the use of numbering plan area codes. With such an arrangement an operator in Philadelphia may dial a number in Camden using only seven digits, but would have to dial ten digits to reach a Newark number.

HOW THE CALLS WILL BE DIALED THROUGH

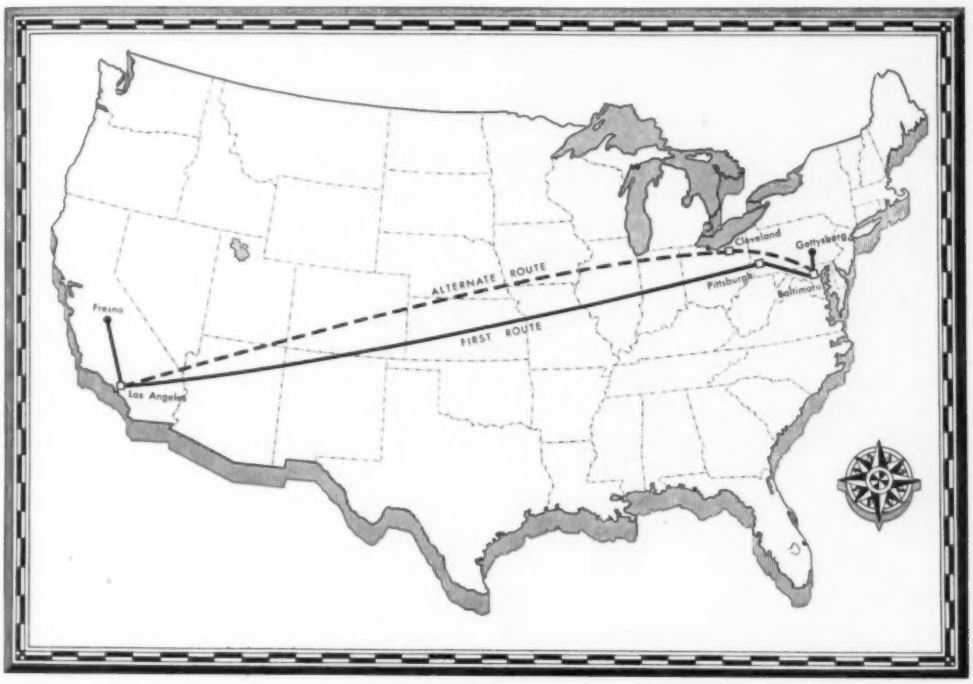
ONCE the toll dial switching equipment is in place, and the universal numbering plan is fully in effect, just how will an outward toll operator go about dialing a long distance call through to its destination anywhere in the country?

A call from Gettysburg, Pa., to

Fresno, Cal., a three-switch call, will illustrate. But before describing a method of the future it may be well to review the present method, to emphasize the contrast.

The routing of many calls across the country involves one or more switches which are made at toll centers, usually primary outlets or regional centers which have been specially designated and equipped for this purpose in accordance with the principles outlined in the General Toll Switching Plan. These switching points, together with about 175 additional toll centers, making about 325 in all, have been selected for operating purposes as the key points in the toll routing network and designated as Class 1 offices.

Each central office in the country is connected to a toll center, which, if not one of the 325 Class 1 toll centers, has direct circuits to one of them. The 325 Class 1 toll centers either have direct circuits to the others or know the first intermediate point to reach in the direction of the called place. Therefore, all an operator needs to know to route a call is the toll center serving the called community and the Class 1 toll center through which its inward and outward traffic is routed. (Approximately 80 percent of all calls are completed over direct circuits and



ROUTING a call from Gettysburg, Pa., to Fresno, Cal.

no routing information is required. Of the remainder, about 17 percent are one-switch and 3 percent are multi-switch.)

Under the present CLR method of operation, when a customer in Gettysburg places a long distance call to Fresno, the Gettysburg operator goes to the routing directions and finds that Fresno is a toll center and that Los Angeles is its Class 1 office. The Gettysburg operator reaches Baltimore, which is its Class 1 office, and says to the Baltimore through operator, "Fresno, Cal., via Los Angeles." Baltimore says, "I will give you Pittsburgh," which is its route to Los Angeles. Reaching Pittsburgh, the Gettysburg operator again asks for Fresno via Los Angeles. Since Pittsburgh has direct circuits to Los Angeles, the next office answering will be Los Angeles, and the Gettysburg operator will then ask for Fresno, and when Fresno answers will give the operator there the called number.

If the circuits from Baltimore to Pittsburgh are busy, an alternative route will be used, the Baltimore operator saying, "I will give you Cleveland," and the advancement of the call will follow the procedure already outlined.

HOW, THEN, will an operator complete so long and relatively complex a call at some future time?

In order to have the necessary switches made at intermediate points under the nation-wide operator toll dialing plan, the operator needs to know only the area and central office codes. Since Fresno is a five-digit city, the national toll code would be, for example, 514 for the numbering plan area and 37, which is FR on the dial, added to the five digits of the listed number, making 10 in all.

Assuming for comparison that the future routing would be the same, the Gettysburg operator would take up a circuit to Baltimore and dial the 10 digits into sender equipment located at Baltimore, a control switching point. (See map on page 107.) Baltimore, Pittsburgh, Cleveland, and Los Angeles are control switching points which might be used in the completion of this call. The equipment at Baltimore would translate the national toll code and determine that the first route is via Pittsburgh. It would select a Pittsburgh circuit, if one were available, and would send along the entire 10 digits dialed by the Gettysburg operator. (Incidentally, the pulsing system used between control switching points will be much faster than the step-by-step pulses generated by the operator's dial.)

At Pittsburgh the equipment would select a Los Angeles circuit but would transmit forward only the Fresno central office code and telephone number, since Fresno is in the same numbering-plan area with Los Angeles. If the Baltimore-Pittsburgh circuits were all busy, the equipment at Baltimore would automatically try the alternative route through Cleveland and the Cleveland equipment would advance the call to Los Angeles.

At Los Angeles—the last control switching point assumed here—the equipment would select a circuit to Fresno and would convert the pulses received from Pittsburgh or Cleveland to the correct number of step-by-step digits and send them out over the circuit to control selection of the

called subscriber's telephone at Fresno.

If the call were for a telephone served by an office tributary to Fresno, the operator at Gettysburg would dial 10 digits as on the call to Fresno, but, of course, with a different office code. When the call reached Los Angeles, the equipment there would recognize from the office code that the call was for a tributary of Fresno and would prefix to the called number sent out over the Fresno circuit the necessary digits to perform the switching operation at Fresno.

Present Step-by-Step Toll Dialing

OPERATOR TOLL DIALING will ultimately work throughout the length and breadth of the country. But before discussing the equipment through which it will function, it is necessary to digress here for a moment to describe a method of operator toll dialing now in daily use over limited areas, and to point out why new types of equipment are necessary to expand it to operate on a System-wide basis. This method of limited range is known as step-by-step toll dialing.

Many hundreds of communities, small and moderately large, have for years been furnished local telephone service through step-by-step dial central offices, and the local dial equipment can be readily adapted to fit into the new toll dialing plan. Gradually the reach of the dial mechanism has been extended out to neighboring towns and cities—even to those at some distance—and today operators are dialing toll calls over step-by-step toll dialing networks over fairly wide areas in Connecticut, Ohio, Michigan, and other places.

In brief, the operator, after receiving from the customer the number he wants in another place, takes up a circuit to the called place and dials the called number, or, in the case of a switched call, first dials a code to secure a circuit to the point beyond and then dials the called number.

For example, on a call from Middletown to Columbus, Ohio (see diagram on page 110), the operator at Middletown plugs into a toll circuit to Columbus in her multiple and dials the Columbus telephone number as listed in the directory. If the call is to Akron, the Middletown operator likewise plugs into a circuit to Columbus, but dials a code which causes the switches at Columbus to connect her with a circuit to Akron and then dials the listed number at Akron. If she were authorized to dial through to Youngstown, she would reach Akron as on an Akron call but would then dial an additional code to reach Youngstown and then the Youngstown listed number.

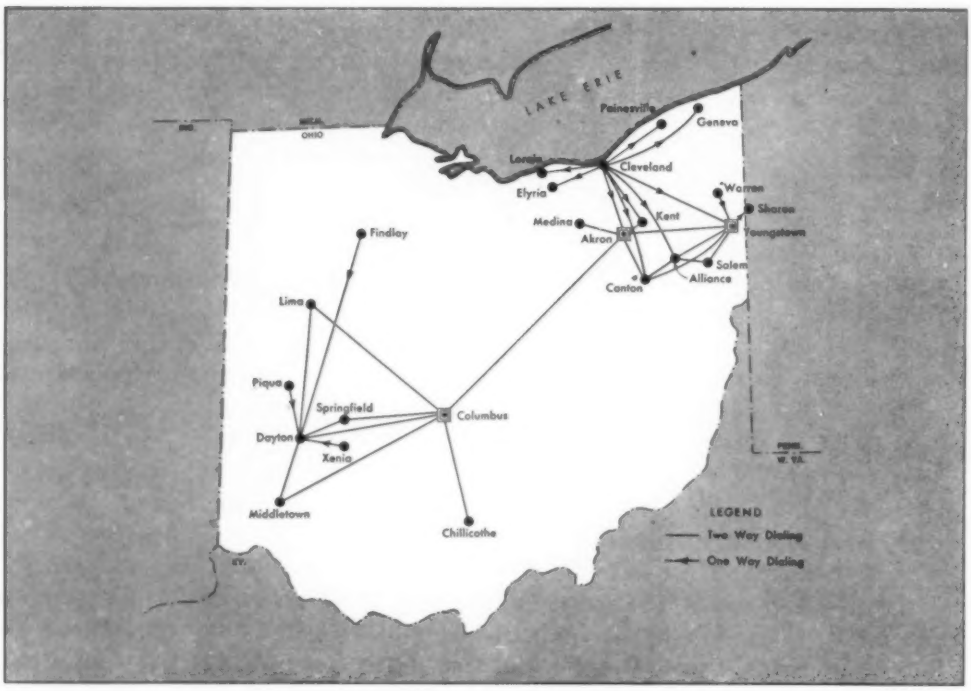
Obviously, this method could be extended to any number of switches, transmission permitting; but note that each switch involves the dialing of additional digits by the operator. On a three-switch call, as many as 16 digits might have to be dialed.

UNDER this method the operator must know the exact route and must have, before she starts to dial, the codes necessary to get through each of the switches involved. Moreover, if the circuits at any point along the line are busy, she must obtain a new set of codes to dial in order to try an alternative route.

Furthermore, calls from step-by-step points cannot be dialed into the large cities served by panel dial equipment without special signal conversion arrangements in those cities. Some form of equipment other than present types of step-by-step toll equipment is required at these larger cities if advantage is to be taken of possible simplifications in coding systems and operating methods and if economies in trunking arrangements are to be realized.

For these and other reasons, step-by-step toll dial equipment alone is not practical on a nation-wide basis.

None the less, such localized step-by-step toll dialing networks are serving well the particular needs of shorter-haul traffic, and they will have other counterparts all over the country among communities which have many interests in common and will form an important part of the national system.



A DIAGRAM of the Ohio step-by-step toll dialing network

Crossbar Toll Switching Equipment

SINCE step-by-step toll dial equipment alone has been found not to be adequate for a nation-wide toll dialing system, let us see what kind of dial equipment will accomplish this much desired operation.

For satisfactory nation-wide operator toll dialing, it is obviously necessary to have the equipment determine the routing. On this basis, a code is assigned which represents the destination of a call, the dial equipment selects the route, operates switches at intermediate points, tries alternative routes if necessary, and completes the connection.

For the larger places the No. 4 toll switching system, already in service in Philadelphia, will, with slight modifications, be adequate. This system permits calls originating in surrounding step-by-step networks to be dialed into the Philadelphia panel and crossbar dial offices for completion or to be routed from one step-by-step network through Philadelphia to other step-by-step networks.

THIS new system utilizes crossbar switching equipment and is of the common control type, providing a high degree of flexibility and speed in the handling of calls. The common control equipment enables the called number to be registered in storing circuits, called senders, after which it is analyzed, or "translated"; and then, depending on the destination of the call and the type of switching equipment which will be called upon to complete it, a choice of routing and pulsing is automatically determined, a circuit to the called point is selected, and the signals which will locate the called number are forwarded to the destination. At this stage, the common control equipment is released, and thus becomes available for handling other calls. The equipment functions as an outward toll tandem board, an inward toll board, and a through switching toll board, but does not replace outward positions of the present type.

FOR busy periods when toll lines are congested, operators are located at a group of delayed-call positions and these operators can complete the calls in the order of filing as circuits become available.

Important transmission improvements and economies are obtained by the use of four-wire switching through the equipment and the automatic switching-in of repeaters whenever they are required.

The No. 4 equipment can receive the called number in terms of dial pulses or of pulses from operators' key sets. For inward ringdown or straightforward calls it provides positions of the call-distributing type without cords or multiple at which the operators key up the desired number, thus recording it in the sender and permitting the completion of such calls as if they had been dialed by the outward operator at the distant end. Completion of calls through any kind of dial equipment or to manual offices is provided.

EXPERIENCE with the Philadelphia installation demonstrates that this type of equipment, with appropriate modifications, can be used in a nation-wide operator toll dialing system.

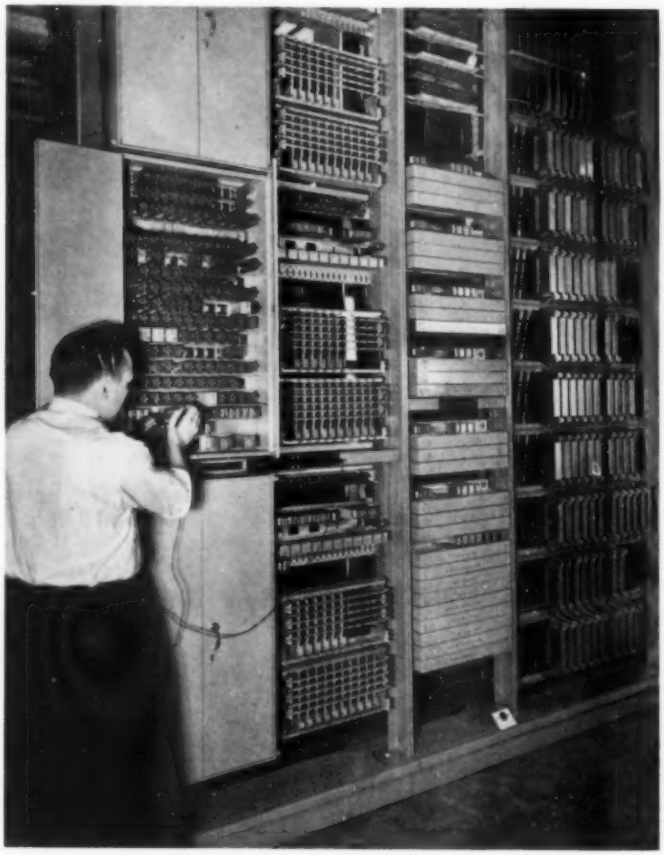
While the present No. 4 system includes most of the features required for nation-wide operation, additional features are also being incorporated to make provision for selecting the most direct route to a distant city. It is to be expected that, as in any new enterprise, continued changes will be made as improvements are devised and greater experience is gained.

Transmission of Signals

FROM the description of the new operator toll dialing system given so far, it will be evident that the long distance transmission and reception of signals or pulses will be an important factor in selecting toll circuits, establishing connections, and, finally, in giving the outward operator supervision of both ends of the connection. Arrangements must also be made for the disconnection of circuits at through switching points under the control of the outward operator.

These signals must follow the general route of the call, but need not be transmitted in all cases over the same circuits on which the conversation takes place. In some cases, direct current circuits will be used between cities, but for the longer distances it is expected to employ voice frequency or carrier circuits.

In any event, the technique of long distance transmission of telephone and telegraph currents which has been so extensively developed in this country will play a most important part in the extension of toll dialing.



OPERATORS in distant cities dial into "senders" which control the connections through the No. 4 toll switching system

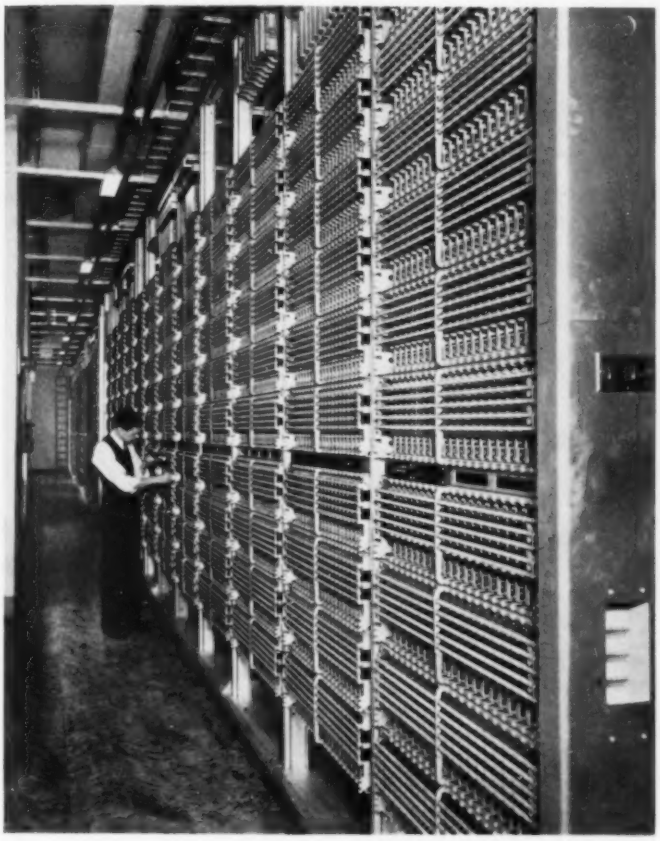
Building on the General Toll Switching Plan

THE REFERENCES already made to the General Toll Switching Plan emphasize the importance of its part in the development of nation-wide toll dialing.

This plan provides the basic routing arrangements, under existing methods of operation, for all calls which require one switch or more at intermediate points. Each toll center is connected to a primary outlet and each of the latter is connected to at least one regional center. All regional centers are interconnected with each other, and it will be evident, therefore, that a call from a toll center at one end of the country to a toll center at the other end would as a maximum require four switches and be routed as follows:

> Toll Center *to* Primary Outlet *to* Regional Center *to* Regional Center *to* Primary Outlet *to* Toll Center

Fewer switches would be required in practically all cases because the eco-



CONNECTIONS are established on a four-wire basis through the noble metal contacts of crossbar switches in the No. 4 toll switching system

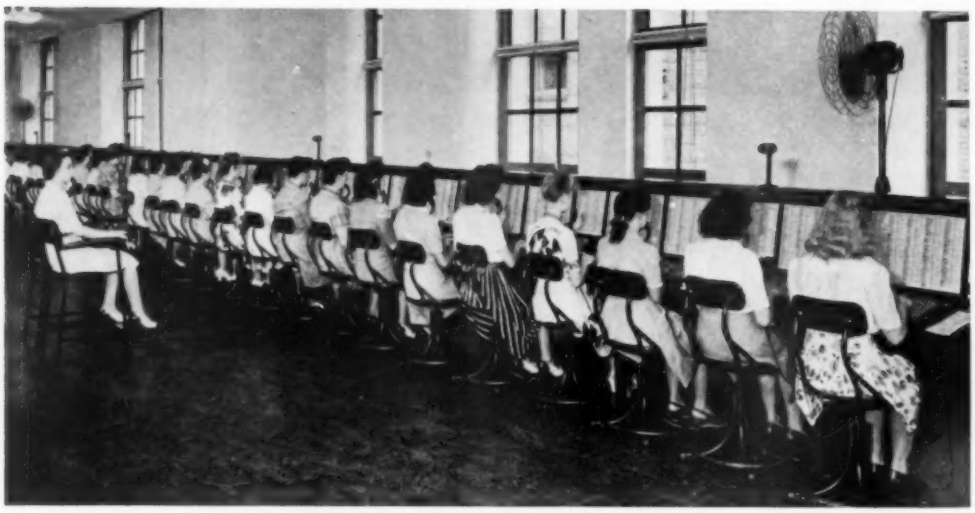
nomical design of the toll plant has resulted in the establishment of direct circuits between many points at great distances from each other and thereby provided more direct routes not requiring so many intermediate switches.

The General Toll Switching Plan forms a firm foundation on which to build the extension of toll dialing. Using this plan, with the major switching points already established for manual operation, it appears practicable to locate crossbar switching systems providing the features necessary for "control switching points" at important switching centers, including the present regional toll centers and most of the present primary toll outlets. Thus provision of "control switching" equipment at not more than 150 points will be adequate to give every outward operator in the 2400 toll centers direct access to such equipment. The remaining toll centers may have step-by-step toll equipment or a simplified form of crossbar toll equipment.

A Long Stride Ahead

WHILE complicated central office mechanisms are required at "control switching points" to make operator toll dialing possible on a country-wide basis, it is apparent that from the operating standpoint this method of handling long distance calls is simple in the extreme. Its advantages have been implied throughout this discussion; they may be summarized briefly thus:

1. By 1940, average speed of service on all Bell System long distance calls had been brought down to 1.4 minutes with an average of about three minutes on multi-switch calls.



CORDLESS positions for setting up calls from cities not yet arranged for toll dialing

With toll dialing, the speed on multi-switch calls is expected to be close to that of direct-circuit traffic and the average speed about one minute.

2. The service will be more accurate and less subject to interruptions and cut-offs.

3. The service will be more uniform and dependable, since fast inward and through service will be available twenty-four hours a day to the full extent of available facilities. The value of this in peaks of traffic and in emergencies during off-hours is apparent.

4. Fast switching will reduce holding time, and automatic alternative routing will make more routes and circuits available for a given call, thus tending to make more efficient use of the toll circuit layout.

AMONG the Bell System's many constructive post-war plans for developing and improving the nation's telephone service, the provision of operator toll dialing has an important place. It will bring to the country's telephone users a faster, more efficient, more dependable—and therefore more useful—long distance service. Much work will have to be done in the years immediately ahead; but accumulated experience and the present toll plant together provide a sure foundation on which to build the bold new structure.

WITHOUT CONTINUOUS TECHNOLOGICAL IMPROVEMENT the Bell System would not have been able to give an adequate or nation-wide service, even if it would have been able to give any service at all. And without continuous technological advance the Bell System would not have employed much of anybody, nor would it have served the economy and speed of other businesses so that they would employ more people. And without continuous technological advance there would not have been either increased values or reduced rates to the public, and certainly no added income to devote to increased wages for the employees.

From "The Bell Telephone System," by Arthur W. Page, Vice President, A. T. & T. Co. Harper & Brothers, publishers, 1941.

As the War against Japan Gains in Power, Increased Activity on our Western Shores Brings Greater Problems to the Pacific Telephone and Telegraph Company

The West Coast in the War

George H. Jess

WAR CONDITIONS have resulted in many unusual telephone construction and service problems throughout the territory of the Pacific Telephone and Telegraph Company. The telephone tasks already accomplished, together with the amazing changes that have taken place, make the period dating from the Pearl Harbor attack seem incredible—even from the present perspective, with the war centered in the Pacific.

The Pacific Company with its subsidiaries, the Southern California Telephone Company and the Bell Telephone Company of Nevada, operates in five states: California, Nevada, Washington, Oregon, and Northern Idaho. The plant of the company was, of course, designed to meet the peace-time needs of developed areas. And in this western country of wide open spaces, developed areas constitute a relatively small part of the territory covered by the company's operations, which comprises 435,000 square miles or 15 percent of continental United States.

When war came, military establishments sprang up like magic throughout the Coast, without consideration to available communication facilities. It followed inevitably that hundreds of miles of new telephone construction were required to serve these reservations, stations, camps, air fields, hospitals, and so on. And there was a further necessity for releasing large numbers of vitally needed toll circuits to serve the Army and Navy, and provide private line networks for tactical operations.

In the years 1942 and 1943, there were 220 Army camps established on the Coast. This brought to 332 the grand total of camps established before and after the war began. The Navy, at the same time, had 196 establishments. There were also 117 government-owned war industries adding to the communications requirements by the end of 1944. In the early part of 1945, the telephone

company was serving approximately 100,000 private branch exchange stations in these installations.

Between June, 1940, and the end of 1944, almost three and one-half billion dollars were spent on the Coast for establishments of the Army, Navy, and war industries. For example, aircraft plants increased from nine, with a production of 2,600 airplanes in 1940, to ten major plants in 1944, which produced 25,189 planes during that year, or 26 percent of the entire output of the nation.

Shipbuilding rocketed from nine shipyards in 1940, producing 12,000 deadweight tons, to 34 shipyards in 1944, producing 6,300,000 deadweight tons. The number of ships launched on the Coast in 1944 was equal to 39 percent of the nation's output of maritime ships in that year. And the term "maritime ships," as used here, excludes vessels built under contracts with the Army and Navy, but does count some special ships, such as LST (Landing Ship Tank).

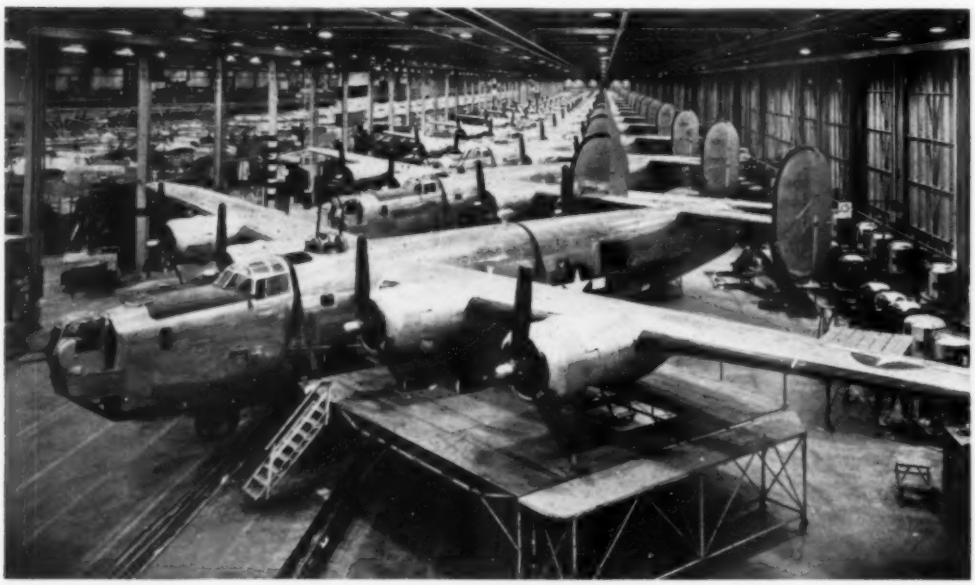
HEAVY INDUSTRY has made great strides and great contributions since Pearl Harbor

These aircraft and shipbuilding

plants employed more than 760,000 people at the end of 1944, and they accounted for the lion's share of total war supply contracts on the West Coast through the year 1944. These contracts through the year 1944 amounted to over twenty-two billion dollars, or more than the national debt in 1932.

This large-scale building of ships and planes caused overnight changes of 309 percent. San Diego owes its 89 percent growth in population over the four-year period to Navy activities and aircraft manufacturing.

This big growth was naturally reflected in telephone traffic. In San Diego, the four years saw toll calls soar from a pre-war figure of 8,000 daily to a daily average of more than 32,000 in the early part of 1945—a 300 percent increase.



PACIFIC COAST airplane factories produced more than 25,000 planes in 1944

in many towns and cities. Typical communities of peace-time America became roaring centers of war production. Take Richmond and San Diego as examples. Richmond, which during March, 1945, had five major shipyards employing approximately 67,000 people, grew from an industrial city of 30,000 in 1940 to a war center with a population of 122,700 at the first of 1945—an increase

The company as a whole handled about 290,000,000 toll calls in 1944; double the total for 1940. Calls to places outside the company's territory totaled more than 7,700,000; nearly ten times the volume of four years ago.

The handling of this telephone business resulted, as might be expected, in correspondingly rapid increases in the traffic forces. Where

at the end of 1940 there were 14,000 traffic employees, the force numbered almost 24,000 at the end of 1944. To secure this gain of 9,800 in the four years, the company hired and trained more than 60,000 people: a commentary on the problems encountered in coping with added volumes, inexperienced personnel, and high turnover.

At the end of 1940, the company had about 2,700 toll-center-to-toll-center circuits. As of December 31, 1944, there were more than 5,000 such circuits—which was several hundred short of meeting requirements. The growth in number of circuits to the East has been the most spectacular, increasing from 184 at the end of 1940 to 690 at the close of 1944; and these, too, were more than 300 short of requirements.

Three Major Projects

THE SITUATION which was met by the company is well illustrated by three major projects involving gross construction costs of $14,600,000.

The first was the construction of facilities on 1,317 miles of route, including 892 miles of new pole line, between Southern California and Central Washington. This was known as the "DBR–1" route.

The second was the "Desert Training Project" of helping to provide communication facilities for a total of approximately 360,000 Army men trained in this area, beginning with General George S. Patton's armored divisions subsequently used in the African invasion.

The third involved the Pacific Company's share of constructing the

LAST YEAR, 39 percent of the nation's new maritime ships were launched on the Coast

transcontinental cable. Each, in turn, was characterized by Bell System "know how."

East of the Ranges

CONSTRUCTION of the DBR–1 pole line was described in a recent issue of this MAGAZINE,* to which account may be added:—The line was built in collaboration with the Army to protect coastal communication in the event of enemy attack and provide service for 19 proposed airfields along the route. While used only in part for its primary purpose, this line east of the Sierra Nevada and Cascade ranges provides a needed additional toll route from Central Washington to Southern California, and has helped to meet the unprecedented traffic volumes stimulated by the war. The line cost $5,600,000 and involved about 900,000 man-hours of labor. At the end of 1944 it provided in the neighborhood of 83,000 miles of telephone circuits and by the mid March of this year it provided 101,000 miles of telephone circuits.

PRODIGIOUS quantities of lumber from the Pacific Northwest have gone into the war

Desert Maneuvers

THE STORY of wartime telephones in the California desert for Army maneuvers is unique in communication history. When General Patton arrived on the scene in March of 1942, he drew a triangle on a map and said, "This is it." A week later, thousands of troops began to pour into the small railroad towns, form into convoys, and disappear in the desert.

The maneuver area covered 30,000 square miles—more territory than do the States of Massachusetts, Rhode Island, New Hampshire and Vermont taken together. Several of the camps were established 50 or more miles from the nearest town or telephone exchange. Telephone men on occasion had to drive 150 to 200 miles to clear a single case of trouble. A round trip of more than 400 miles was required to visit the three toll offices at Blythe, Needles, and Whitewater in this area. Eleven telephone buildings were built there, including the toll offices and four repeater stations. Thirty-seven positions of

* See "Building the West's New Telephone Route," MAGAZINE, Winter 1944–45.

switchboard were installed, 50 private branch exchange switchboards, 2,000 telephones, more than 50 public telephones, and some 25,000 miles of physical and carrier circuits. Gross construction for the project amounted to $1,700,000, and 175,000 man-hours went into the job.

Troops began to pitch tents at the base camp, later named "Camp Young," the first week in April. The nearest Southern California Telephone Company office was Whitewater repeater station, 65 miles away. Other "close" telephone neighbors, by desert distances, were the San Bernardino toll office of the Southern California Telephone Company, 105 miles; and the Thermal office of the independent Coachella Valley Telephone Company, 23 miles.

WESTERN ELECTRIC installers moved into the camp about June 1, the day the Army contractor completed the building to house the dial switching apparatus. On July 15, the 400-line dial system was placed in service, and connected with a distributing system built by the Southern California Company, covering eight square miles.

Camp Young by this time accommodated 10,000 troops. The First Corps was just getting into large-scale maneuvers when the order came to head for what turned out to be North Africa. The Second Corps poured in to replace the departing outfit. Huge troop movements and almost daily refinements in plans created an avalanche of traffic. The Army switchboards at the camp were supplemented by a mobile switchboard rushed by the company from Los Angeles.

Next arrivals were equipment experts from Riverside and Los Angeles, who worked around the clock, installing tie trunks and other modified arrangements to link the mobile equipment and the dial system. Less than 48 hours elapsed before Army personnel were operating the board under the instruction of two women traffic supervisors.

NEW PLANTS have been constructed for the production of 100-octane aviation gasoline

Many new telephone pole lines were built. By late October, a repeater station had been completed at Thermal, and the Whitewater toll office was opened to serve Camp Young. The mobile switchboard moved out, its work well done.

SHELTERS for outdoor telephone booths at Army camps were built to give some protection against the intensity of desert weather

A "PUBLIC TELEPHONE" trailer was used at times in various localities to provide or supplement service for the men in camps

Another phase of the project was the construction of many difficult telephone lines, handled by a selected crew of the Southern California Telephone Company. This work included a 65-mile aerial cable, 40 miles of underground cable, and hundreds of miles of open wire. Many tablets were taken to maintain balanced body chemistry. The supreme test came in September, when the crews dropped everything to do a special piece of work for the Signal Corps, just before the first large-scale maneuvers. Some 170 route miles of telephone facilities had to be

A SIGNAL CORPS officer and a telephone company construction superintendent review the day's work. During much of the desert job, telephone men and Army men worked side by side

of these new facilities were placed on poles of the two transcontinental lines traversing the region, but many miles of new poles were also set.

In the midsummer heat, the workers donned heavy gloves to handle blistering-hot tools and wires. Everybody wore dark glasses. Salt constructed by and for the Army throughout the training area. Fifty-three miles of pole line were constructed by the Army and 117 miles by the telephone company.

The three hottest weeks of the year saw the telephone men working ten hours a day, in deep sand navi-

gable only by tanks and half-tracks, and through mountains where the holes for setting poles frequently required dynamite blasting. The crews strung 1,400 circuit miles of wire, set 1,000 poles, and installed 1,500 crossarms.

Maximum use was made of carrier systems to conserve copper. At Whitewater, for example, carrier equipment was increased 300 percent. Soon the station had 20 repeatermen, as compared with 12 before the rush began. The heavy traffic also created an immediate need for women to operate new toll board positions. About 115 operators were required. Women throughout the Southern California Company territory volunteered for the assignment and were stationed at Whitewater, Blythe, and Needles.

The typical Army division camp in the desert was of the "rag" variety, consisting of tents—and no improvements. The soldiers lived a life duplicating the conditions they would find overseas. At any given time, there were more than 100,000 troops to direct, transport, hospitalize, feed and clothe independently of normal supply channels; for the training was

AN ARMY JEEP accompanies these telephone trucks with their reels of wire

on the basis of actual war conditions, thousands of miles from home. Wire communications were essential in effecting coördination.

The wire communications were essentially a private line network principally for intra-communication in the desert. While the extent of the network varied from week to week, it was normally composed of about 3,000 miles of Bell System channels and some 2,000 miles of Army circuits. There were 100 long haul circuits, all interconnectable. Paralleling the telephone network connecting several Army locations were several networks serving many private-line teletypewriters. Augmenting other means of communication with the outside world, the Army used several teletypewriter exchange services.

The maneuvers called for most unusual telephone arrangements, and on short notice. Frequently a complete rearrangement of circuits had to be made in less than eight hours. It was not unusual to establish new circuits and reroute existing circuits within the hour. In the "free" maneuvers, where troops in the field operated on battle problems without

A TELEPHONE construction camp in the Army maneuver area of the California desert

outside direction, the telephone company provided camp telephone managers to assist Corps Signal Officers for each "side" in the battle. These telephone men moved with the Army in the field.

Throughout the desert activity, the question of "How many public telephones are needed?" was always current, but the real question was, "Can we furnish any at all?" Normally, 300 public telephones would not have been considered too many. But only by using the utmost ingenuity were the company's camp telephone managers able to establish 50 to 70 stations for the entire desert area.

This sparseness of public telephones was due to the fact that the circuits were required for Army calls. Out of 33 talking channels on lines between Camp Young and Iron Mountain, for example, only three were available for personal calls. And along this line during the summer of 1943 there were 60,000 men waiting to call outside. It was arranged to increase the number of circuits available for soldiers' personal use by routing all calls through the Army switchboards, so that when

THEIR day's work completed at the Whitewater toll office at the edge of the desert, these operators are being taken to a hotel at Banning leased for dormitory purposes

official calls slacked off, the men could place calls direct with the long distance operators. By this means, a camp having three to six administrative lines could increase the number of public telephones by that amount. At Camp Coxcomb, with 20,000 men, located 75 miles from the nearest town, two public telephones handled 1,000 calls in a month. A trailer installation elsewhere handled 6,000 calls in two months. This was typical.

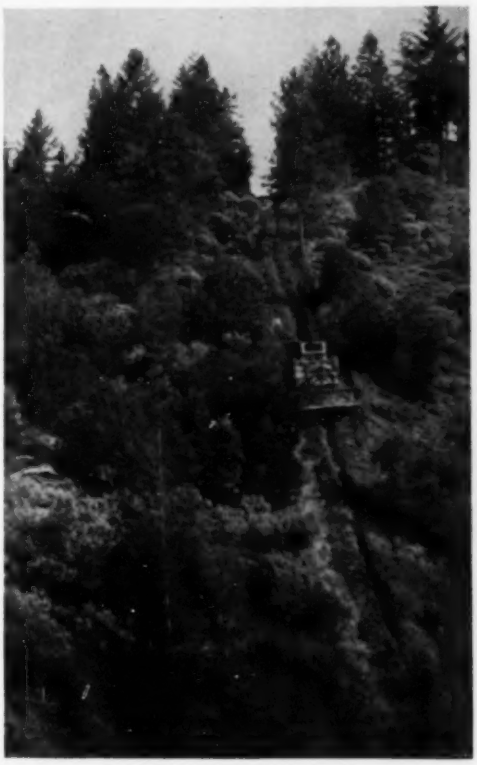
THERE WERE a lot of "headaches" in keeping the public service operating smoothly, but the telephone people did their best, and, with the cooperation of the Signal Corps, turned out a fine piece of work. The desert heat caused unusual service problems. Handkerchiefs had to be used to hold the receiver. There was no shade for booths, and they rested on sizzling ground. There were no long conversations! The paint on one batch of booths was ruined by the heat within 24 hours after arrival. Lean-to shelters were built to shade the booths, shelter walls erected against desert blasts, and floors installed. With these improvements, a man could wait or telephone without either frying or freezing.

Once, when telephone men went by truck to recover two booths from what was reported to be an abandoned camp, they found another Army outfit had moved in. The men were using the booths as prized shower stalls.

Today, a majority of the desert locations which were so active in the early days of the war have returned to wilderness. The entire telephone building at Blythe was recently dismantled and moved, switchboard and all, over 200 miles to Chula Vista, near San Diego, where it is again a "hot spot" of war calls.

Installing the TC Cable

THE THIRD big job was the Pacific Company's part of the transcontinental cable,* installation of which was undertaken to provide more circuits between the east and west coasts in anticipation of the possibility of



TRACTOR and rooter clear a furrow for the transcontinental cable up a steep hill

* See "Engineering the Transcontinental Telephone Cable," MAGAZINE, November 1941.

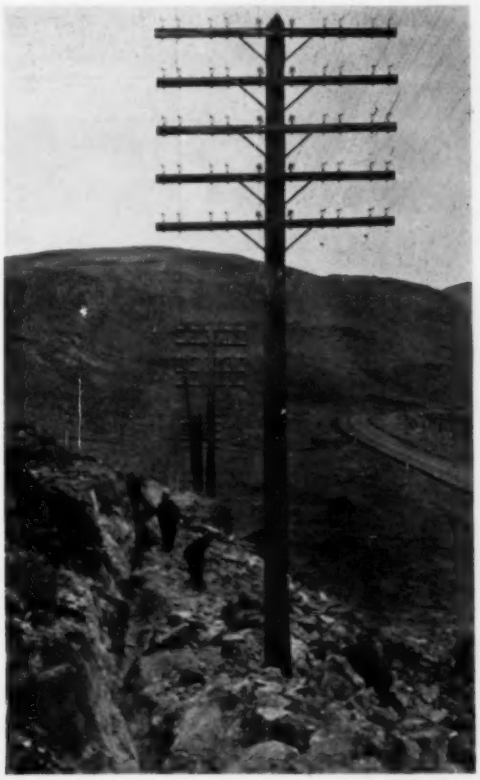
CLEARING the right of way for the transcontinental cable went ahead in all weathers

THE Pacific Company's cable train plows in the cable west of Wendover, Utah

war with Japan. The company, in coöperation with the Long Lines Department and other Bell System Companies, started this cable work in the autumn of 1940. The cable was open for service in December, 1942. The Pacific Company's and Bell Company of Nevada's share in gross construction amounted to $7,300,000 and involved 500,000 manhours of telephone company work.

MUD fought the progress of the cable train in some localities

THE combined teamwork of the Bell System—the O. & E. staff of the A. T. & T. Company, the manufacturing and supply capacity of Western Electric, and the coöperation of other Associated Companies—enabled the Pacific Company to muster the needed material and personnel to complete the jobs in the shortest possible time.



TRENCHING by hand was sometimes necessary in rocky terrain

The Pace Accelerates

HUGE population shifts within the coastal territory, as well as from other parts of the country, created tremendous demands for service, over and above military and war industry demands. As of May 1, 1945, the Pacific Company had 256,140 unfilled applications for main

telephones; and 187 central offices designed to serve 1,000 or more main telephones had reached their capacities—or 50 percent of the total of such central offices which serve about 96 percent of the telephones in the Pacific Company system.

The acceleration of the war in the Pacific theater of operation continues. Big installations are still very much in the present tense. For example, the Kaiser steel mill at Fontana, California, which was set down in the midst of orange orchards in 1942, is now said to be the world's largest producer of heavy ammunition. A large Navy project is under construction involving an investment of $30,000,000 and employing almost 9,000 people.

SPLICERS of the Pacific Company and Long Lines make the final splices in the transcontinental cable at the Nevada-Utah state line

With V–E Day, the entire might of America's war effort turned westward, and the Pacific Coast accelerated its already fast pace. It follows that the telephone company will meet increased service demands. The coast, with 40 air bases suitable for training, is a logical location for the re-assembly of air forces from the European theater. Shipments of men and materials will logically increase from coast ports, staging areas, and embarkation points.

The telephone company's construction program for 1945 contemplates the installation of central office equipment, private branch exchange switchboards, and other equipment on subscribers' premises; and exchange and toll lines to serve the growing needs within our territory to the extent that material and manpower are available.

THESE are some of the highlights of the situation on the Pacific Coast. The telephone company has a definite problem, calling for continuous and effective action in promptly providing necessary facilities and services. In addition to the materials and manpower necessary for carrying out the required construction to provide for the growth of this business, additional traffic operating employees are needed to handle the increasing number of local and toll and long distance calls.

The provision of the necessary additional facilities and employees will

be a stupendous task. In all of the forward march, shoulder to shoulder, the Pacific Company and its people have every faith and confidence that, through the aid and assistance of the centralized staff and the other Associated Companies, this fine record will be maintained.

Who's Who & What's What *in This Issue*

THE willing, courteous, and effective assistance of many members of the Army and Navy, of all ranks, is evident in the section of this issue dealing with *Electrical Communications in World-wide Warfare*. Without their aid and counsel the necessary information could not have been compiled nor the photographs obtained. And since it is not practicable to make acknowledgment here to so many individuals, the editors express in this fashion their sincere thanks and appreciation to all those in the Services whose help has made possible so unusual a feature in these pages.

Neither is it feasible to give "credits" individually for so many photographs. They were secured—with a few exceptions—from the Army's Bureau of Public Relations, the Signal Corps, the Army Air Forces, the Navy, the Marine Corps, and the Coast Guard. They give abundant evidence of the splendid work of the Services'

JAMES J. PILLIOD

HAROLD L. RYAN

GEORGE H. JESS

photographic sections in making a pictorial record of every aspect of this war.

IT IS a startling picture of long distance service in the not too remote future which JAMES J. PILLIOD and HAROLD L. RYAN paint. As assistant chief engineer, and assistant vice president in charge of the traffic division, respectively, of the A. T. & T. Company's Department of Operation and Engineering, they are in key positions to discuss the equipment and methods which will make operator toll dialing possible on a nation-wide basis, and the improvements in service which will come with it.

Starting with the Long Lines Department in 1908, Mr. Pilliod had become by 1914 its division plant engineer in Chicago. In New York since 1918, he had been successively the Department's engineer of transmission, engineer, and general manage before transferring to his present post in 1943. Mr. Ryan's Bell System career, entirely devoted to work in traffic, began with the New England Telephone and Telegraph Company in 1920. Transferred to the O. & E. Department of A. T. & T. in 1927, he was traffic results engineer from 1940 until his present appointment earlier this year.

THE PROBLEMS which the war brought to telephone people on the Pacific Coast are vividly set forth by GEORGE H. JESS. Beginning with the Pacific Telephone and Telegraph Company in 1910 as a splicer's helper, he is now the company's operating vice president. In the intervening 35 years his experience has ranged from lineman to sales representative to general commercial manager and, just previous to election to his present position in 1943, assistant vice president in charge of operating matters and vice president and chief of staff.

TONIGHT in Maine a fisherman is listening to the same music you are hearing. In Wisconsin a farmer tuned in right after supper and is hearing this program. A banker and his children are listening in Texas. And on the West Coast a wounded seaman, just back from the Pacific, will hear it on a bedside radio in a hospital.

For one of the things radio has done is to bring the beauty and solace of the world's great music to all people in all places. Here in America the people in little, out-of-the-way spots can hear and enjoy the performance of distinguished artists the same as those in great metropolitan centers. There is no remoteness any longer.

Radio and telephony combine to make this possible. Many radio stations are linked together for a network program such as this—linked by telephone wires especially designed for the transmission of music, so that it may be sent to you with all the clarity and fidelity of tone with which it is produced by the great artists who, week after week, appear in our studio.

We of the Bell System consider it a special privilege, in times like these, to be able to send you these great artists and this fine music. May it bring to all of you a large measure of enjoyment.

From a "Telephone Hour" radio broadcast